

SCIENCE

18 May 1956

Volume 123, Number 3203

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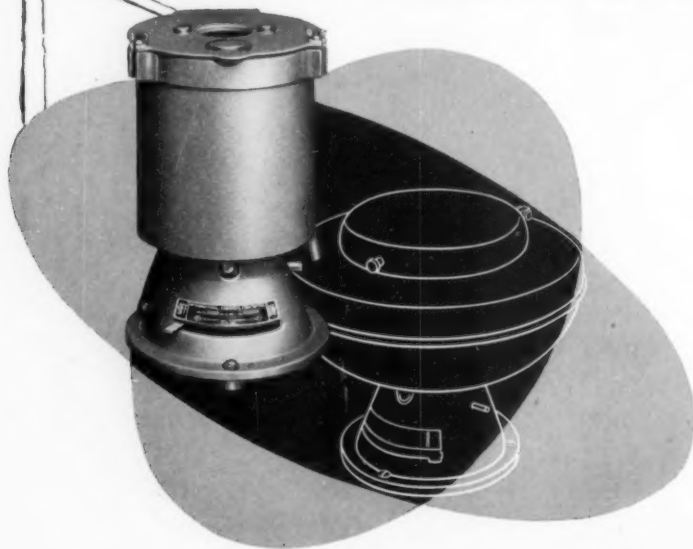
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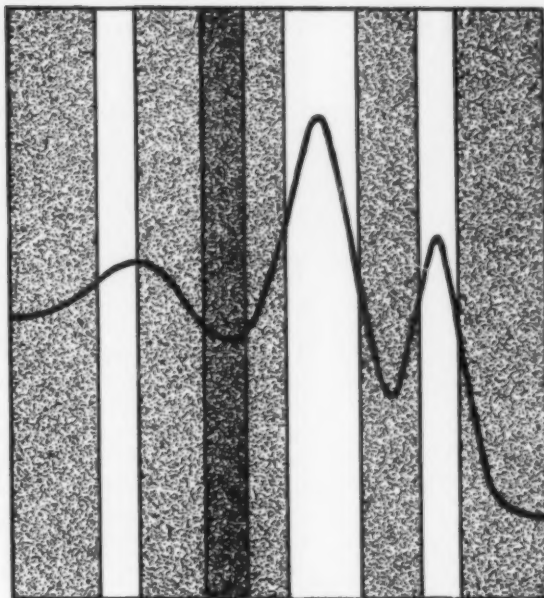
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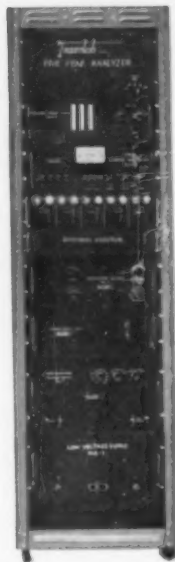
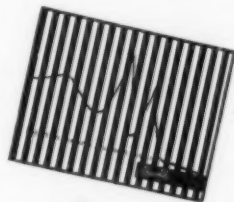
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SCIENCE founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879.

SCIENCE is indexed in the *Reader's Guide to Periodical Literature* and in the *Industrial Arts Index*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see *Science* 123, 714 (27 Apr. 1956).

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A National Medical Library

From 1836 to 1952 the Armed Forces Medical Library developed under the auspices of the Army. Since 1952 it has been under the control of the Department of Defense. Thanks to a series of able directors, the library has operated effectively. However, if a solution to the problem of limited budgets and insufficient space is not found, a difficult task may become an impossible one.

Research workers in the medical and biological sciences know about the Armed Forces Medical Library chiefly through its notable publication, the *Current List of Medical Literature*, in which something over 100,000 articles are listed annually. The library's collections total nearly 1 million volumes, and its accessions, which include more than 10,000 serial publications, come in at the rate of nearly 100,000 pieces per year. During 1955 the library filled more than 37,000 requests for books for interlibrary loans and more than 92,000 orders for photoduplications (photostats and microfilms).

The building in which the library is housed is a red brick monstrosity dating from one of the sorriest periods of American architecture. It is unusual for a period of more than a few months to pass before another leak is sprung in the antique roof; the stacks are so nearly full that a great deal of reshelving has to be done to take care of accessions; space available in the building today will be completely filled in 2 years; and, what is probably of the greatest importance, the collections are in constant danger of destruction by fire.

In July 1955 the Congress recognized the need for action, but its intentions were not carried out. An appropriation bill was passed, which authorized an expenditure of \$350,000 for architects' plans for the library. In December 1955 the Department of Defense decided not to include any appropriations for building a new library in its budget request for fiscal 1957. Accordingly, the Navy's Bureau of Yards and Docks (there are some administrative complications here) was advised not to ask for apportionment of the funds for architects' plans already appropriated by the Congress.

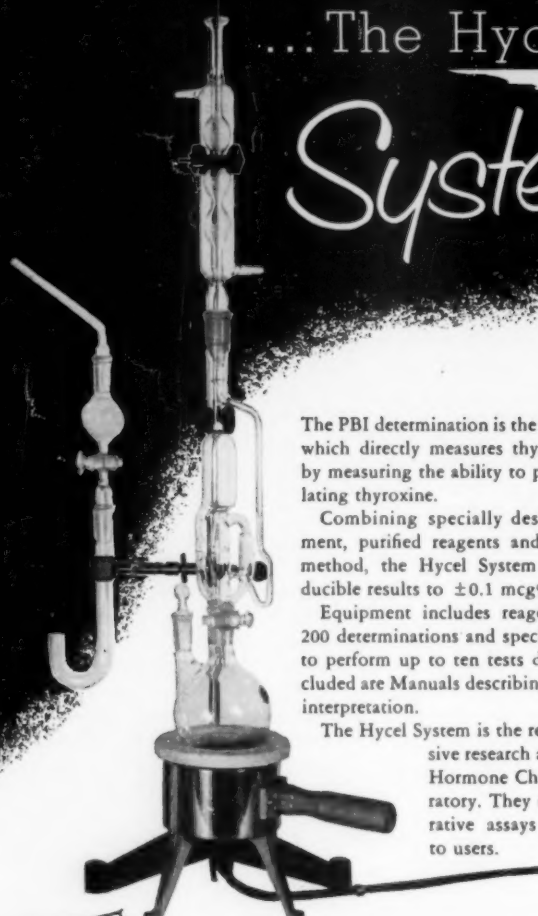
If the library is, as many have contended, a national medical library, then it is appropriate that it should be an independent branch of the Federal Government, as recommended by the Task Force on Federal Medical Services of the Hoover Commission. The Task Force went on to say that "The needs of a National Library of Medicine are neither in theory or practice familiar to, or a natural concern of, the Department of Defense."

Senators Hill and Kennedy have recently introduced a bill (S. 3430) that embodies many of the recommendations of the Task Force. They propose the creation of a "National Library of Medicine," which is to be governed by a board of regents made up of 12 people appointed by the President and, as ex officio representatives, the surgeons general of the Army, Navy, and Air Force, and Public Health Service, and the librarian of Congress. The board would be authorized to have plans drawn for an appropriate building, to choose the site, and to condemn land, if necessary.

We join numerous others in urging the Congress to act favorably on this bill during the present session. A National Medical Library properly housed would be a great national asset for medicine and related sciences and for the general public.—G. DuS.

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Measurement of Radioactive Ages of Rocks

L. T. Aldrich

The association of the naturally occurring radioactive isotopes, U^{238} , U^{235} , and Th^{232} , with their respective daughter isotopes, Pb^{206} , Pb^{207} , and Pb^{208} , has now been known for a quarter of a century. The successful application of this association to the measurement of mineral ages with the collaboration of Nier and Baxter (1) soon followed their discovery. Between this classic pioneer work and 1950, only a handful of mineral ages were accurately determined. The reason for this was primarily the requirements that the mineral contain 1 percent or more of uranium and/or thorium so that the chemical determinations of these two elements and the daughter element, lead, could be made by the standard techniques of analytic chemistry. Even for such minerals, serious errors of analysis were very common. On the other hand, the isotopic analysis of the daughter lead from these minerals could always be accomplished with the amount of lead required for the chemical determination; hence, the mass spectrometric requirements have never been a limiting factor on measurements of mineral age.

As a result of the chemical requirements, the kinds of rocks that could be dated were limited to pegmatites that contain uraninite, monazite, and similar minerals. This in turn seriously limited the size and number of geologic formations that could be dated. It was found during this pioneering period that the three ages derived from the radioactive series of uranium and thorium on the same mineral were often discordant, and in fact the geologic time scale given by Holmes (2) is based in part on dis-

cordant ages which are very difficult to interpret unambiguously. A method of measuring the age of more common rock-forming minerals has long been sought.

Several factors have provided opportunities for geophysicists and geochemists to reexamine the methods of radioactive age measurements. Among these factors are new chemical methods that have been developed in the last 15 years, the availability of separated isotopes from the U.S. Atomic Energy Commission, and the extension of the range of sensitivity of mass spectrometers by several orders of magnitude. The result of this technology has been a new kind of analytic chemistry, which today makes the precise chemical and isotopic determination of microgram amounts of parent and daughter elements as straightforward as that for milligram and greater quantities 20 years ago. Indeed, in our own laboratory this is referred to as a "physicist's chemistry," primarily because of its immediate utility by one with relatively unsophisticated chemical background. It is the purpose of this article to discuss the applications of this new chemistry, along with its limitations, to the problem of mineral age determination. In doing this, it will be necessary to outline briefly the general procedure, so that the credibility of the method can be established. Some of the results of measurements that have been made are presented, along with their implications for the future.

There is good reason to present the state of progress at this time, since the newer techniques have already provided an indication of their usefulness and simplicity in providing potassium-argon and rubidium-strontium ages that agree for rocks for which the two indicated

uranium-lead ages disagree. These measurements have also shown that rubidium-strontium and potassium-argon ages can be made to agree with concordant uranium-lead ages by a suitable choice of half-lives for K^{40} and Rb^{87} . The values so found lie within the large range of values for these two constants, which have been obtained by direct laboratory counting experiments.

The Problem

Modern chemistry has not changed the basic assumptions on which the measurement of a reliable mineral age are based. These assumptions are as follows. (i) The parent element content of the mineral has been changed only by its radioactive decay. (ii) All the decay products produced by the parent element have been retained since the mineral was formed. (iii) The geochemical separation of the parent and daughter elements at the time of formation of the mineral was sufficient to make the determination of the decay products unambiguous. For example, if a uranium mineral does not exclude all lead at the time it is formed, it is difficult to determine with complete certainty the isotopic abundance of the lead that it incorporated at the time of its formation. (iv) The radioactive decay scheme of the parent element is well established.

The contribution of modern chemistry is rather one of extension in the number of minerals on which these four assumptions may be tested. The extension is in two directions. The first is to minerals that contain much less of the parent element but maintain a good geochemical separation of the parent and daughter elements when they are formed. Examples of this extension include the accessory minerals that are common in granite—zircon, sphene, and apatite, to which the uranium and thorium methods may be applied, and muscovite and biotite, on which the rubidium-strontium decay may be used. All of these minerals contain less than 1 percent of the parent element and some less than 0.1 percent, but the daughter element of these minerals that is not due to radioactive decay is often of the order of 0.0001 percent; hence, the determination of the age of such minerals had to wait for the technology that I am going to describe.

The author is a member of the staff of the department of terrestrial magnetism at the Carnegie Institution of Washington, Washington, D.C.

Table 1. Naturally occurring radioisotopes and their properties.

Isotope	Daughter isotope(s)	Type of decay	Half-life (yr)	Abundance of parent isotope
K ⁴⁰	Ca ⁴⁰ Ar ⁴⁰	beta electron capture	1.26-1.51 × 10 ⁹ 1.16-1.61 × 10 ¹⁰	1.22 × 10 ⁻⁴ g/g K
Rb ⁸⁷	Sr ⁸⁷	beta	4.0 - 6.3 × 10 ¹⁰	0.283 g/g Rb
Th ²³²	Pb ²⁰⁸	alpha	1.50 × 10 ¹⁰	1.00 g/g Th
U ²³⁸	Pb ²⁰⁶	alpha	7.13 × 10 ⁸	7.1 × 10 ⁻³ g/g U
U ²³⁵	Pb ²⁰⁷	alpha	4.50 × 10 ⁹	0.9929 g/g U

The second extension is to minerals containing radioactive elements that have either a very long half-life, such as Rb⁸⁷, or a very low natural abundance, such as K⁴⁰. Examples of such minerals are micas and feldspars in pegmatites and granites. The common occurrence of these minerals and the ease of separating them from contaminating minerals makes this second extension just as important as the first. There remains the task of evaluating the results obtained by these two extensions.

Table 1 lists the radioactive isotopes that are commonly used today for mineral age determinations, their daughter isotopes, types of decay, decay constants, and abundances as found in modern samples of the elements. It may be seen from this table where the difficulties lie in the application of the decay of Rb⁸⁷ and K⁴⁰. The range of values for the decay constants of these two isotopes makes the interpretation of the absolute ages as determined by these two methods difficult, but it does not, of course, affect the relative ages that are determined by the decay of either isotope alone. The only part of the K⁴⁰ decay that is generally applicable to age determination is the K⁴⁰ → Ar⁴⁰ branch. Since Ca⁴⁰ is the most abundant of the isotopes of a very commonly occurring element, contaminating calcium, whether it is present in the mineral or added during the processing of the sample to be analyzed, will obscure the radiogenic calcium that has been formed in all but the most favorable of minerals. On the other hand, it has been shown that one cannot always use zircons, monazites, and other minerals with a relatively low uranium content to obtain unambiguously the age of a rock. The two uranium-lead ages often differ from each other markedly, and the thorium-lead age on the same mineral is almost always drastically lower than either of the others. In fact, the only uranium mineral that has consistently given two concordant uranium-lead ages is pegmatitic uraninite, which occurs relatively rarely. Thus we are faced with the problem of whether to use minerals that demonstrably give discordant ages or those for which the absolute ages will be of less significance because of uncertainties in the physical constants of the

decay. Before pursuing this question further, I wish to present a brief discussion of the chemistry that makes this decision necessary.

Analytic Techniques

The basically new tool that makes possible the microgram analyses required for this work is that of stable isotope dilution. This method was first used for solid-sample analysis by Inghram and his colleagues at the Argonne National Laboratory and the University of Chicago. Inghram (3) has reviewed the applications of isotope dilution, and it is sufficient to say that the method is now well enough established to be used with confidence on any analytic problem that involves an element with two or more stable or long-lived radioisotopes. The group at the Carnegie Institution of Washington

has applied this technique extensively to all of the radioactive decay schemes shown in Table 1. Other laboratories have used the method on one or two of the decay schemes. Although the reader is referred to Inghram for a detailed review of applications of the method, an example will be given here to make this presentation complete.

Figure 1 shows samples of the mass spectra that must be taken to complete the analysis of the thorium in a sample of zircon. As is shown in Fig. 1a, naturally occurring thorium is pure Th²³². In Fig. 1b is shown the mass spectrum of thorium extracted by G. R. Tilton of the department of terrestrial magnetism from a uranium mineral low in normal thorium. The Th²³⁰ shown is that in equilibrium with the U²³⁸ in the mineral; it is very useful as a tracer solution for thorium analyses by isotope dilution, since it has a half-life of 85,000 years. From several such spectra, the ratio Th²³⁰/Th²³² of the tracer may be determined with a precision of 1 percent or less. A tracer solution of the thorium with this high Th²³⁰ content is then made up. A solution of pure normal thorium with an accurately weighed amount of thorium is then made up to standardize the tracer solution.

Figure 1c shows a sample of the mass spectra from which the tracer solution was calibrated. It is seen that the ratio Th²³⁰/Th²³² for the mixture is different

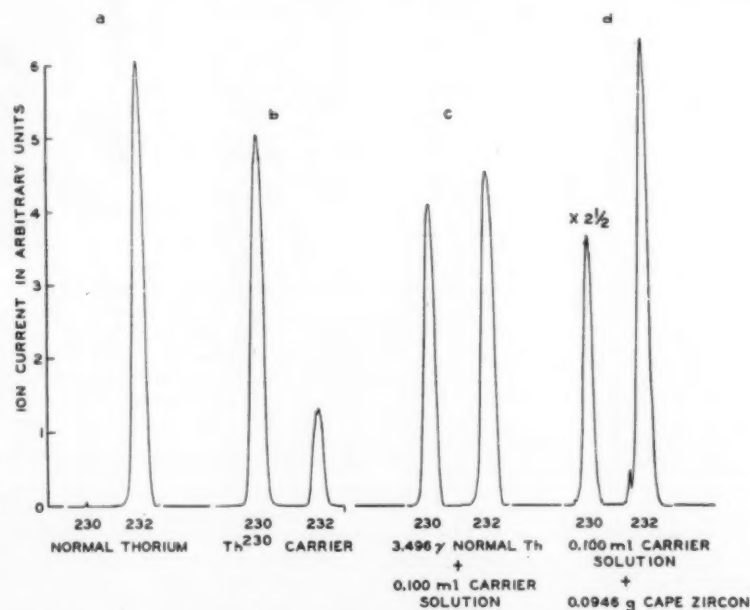


Fig. 1. Mass spectra for the determination of small amounts of thorium in minerals by isotopic dilution. (a) Normal thorium, (b) Th²³⁰ carrier solution, (c) spectrum for calibration of carrier solution, (d) mass spectrum of thorium from mixture of 0.1 milliliter carrier solution and thorium from sample of zircon from which thorium content of zircon is calculated.

from that of both normal and tracer solutions. From this isotopic ratio, that for the tracer and normal solutions, and the amount of normal thorium in the mixture, a straightforward calculation will give the concentration of the tracer solution. With such a standardized tracer solution on the shelf, one may then proceed to determine the thorium content of any mineral that has a thorium-to-uranium ratio of 10^{-3} or greater with considerable precision and with an ease that is quite surprising.

Figure 1d shows examples of spectra needed for the determination of the thorium in the zircon extracted from a granite that was obtained from a quarry near Cape Town, Union of South Africa. From the spectra in Fig. 1a, b, and c one may calculate that the Th^{230} content of the tracer solution is close to 4.2 micrograms per 0.1 milliliter. From this and d it is seen that the Th^{232} content of the zircon is about 4 times this, or 15.7 micrograms per 0.0946 grams of zircon. Duplicate analyses of samples of the same mineral have always repeated their results within 5 percent and more usually to 2 to 3 percent. Thus, the precision of analysis is adequate for most questions to be asked of mineral age determinations.

For the minerals that, as a result of these new techniques, are now available for age determinations, the major chemical problem is the extraction and purification without contamination of the microgram amounts of the daughter element. This problem has several facets, the first of which is to obtain from the rock mineral separates that are completely free from any mineral containing appreciable amounts of the daughter element. For instance, trace amounts of fluorite or apatite in a biotite separate from a granite will make a radiogenic strontium determination of the biotite very difficult. Similarly, small amounts of galena, pyrite, or molybdenite mixed with a zircon sample make the lead determination, both chemical and isotopic, difficult to interpret. Good advice from those who are adept in the use of a petrographic microscope and in the interpretation of x-ray data on minerals is essential to the success of this phase of the work.

Having a good mineral separate, one must then be able to dissolve the mineral with acids or by a combination of fusion and acids without contamination or loss of the elements sought. Once the sample is in solution, the proper amount of isotopic tracer is added. This usually involves adding the tracer for determining the parent to a small aliquot of the solution and adding the traces for determining the daughter isotope to a larger aliquot or the whole dissolved sample. For lead analyses, where three

radiogenic isotopes are involved, a third aliquot must be reserved for analysis of the isotopic abundance of the lead. When tracer solution is added to an aliquot, care must be exercised to be sure that the solution is homogenized so that equilibrium between all isotopes of the same element may be assured. Once this equilibrium is assured, the requirements of the chemical procedures used to extract the element desired are (i) that the yield is sufficient for a mass spectrometer analysis, (ii) that no contamination results, and (iii) that the separation from elements giving ion currents at the same mass position is complete. The general availability of radioactive tracers of high specific activity for all the daughter elements studied makes the evaluation of any procedure evolved relatively simple.

One such method that has been found very useful for separating microgram amounts of calcium and strontium from potassium and rubidium minerals makes use of ion-exchange resin chromatography (4). Figure 2 shows this separation with a very simple procedure that has been developed at the department of terrestrial magnetism. The only element that occurs commonly and with large abundance in these minerals and whose behavior has not been investigated on such a column is aluminum. Such an investigation has not been necessary, for experience has shown that large excesses of aluminum do not interfere with the spectrometer analyses of calcium and strontium. The completeness of the separation of the rubidium and strontium is essential to the success of the rubidium-stron-

tium method, because both parent and daughter have essentially the same mass.

For a mica, for instance, 100 to 200 milligrams of sample is dissolved in hydrofluoric and perchloric acids and equilibrated with from 1 to 20 micrograms of Sr^{84} tracer and 100 to 500 micrograms of Rb^{87} tracer. The solution is dried and dissolved as completely as possible in 2 to 3 milliliters of warm 2.5N HCl. This solution is cooled to precipitate most of the (K,Rb) perchlorates. After the solution has been centrifuged, the liquid portion is taken up in a pipette and placed on top of the ion-exchange column, and the precipitate is set aside for analysis of the rubidium in the sample. When all the sample has passed on to the column, 65 milliliters (25 fractions) of 2.5N HCl is eluted through the column and discarded. As may be seen from Fig. 2, this fraction contains the iron, sodium, potassium, rubidium, and calcium in the sample. A clean beaker is then placed under the column, and an additional 25 milliliters of acid is passed through the column to elute the strontium of the sample. The usefulness of the columns cannot be overemphasized. Their simplicity and low requirements for clean glassware make them essential components of this physicist's chemistry.

The second procedure is that adapted by G. R. Tilton and C. C. Patterson (5) at the University of Chicago for their classic uranium and lead studies on the minerals of the Essonville granite. The basis of their procedure after sample dissolution and addition of the tracers involves solvent extraction. Again, expe-

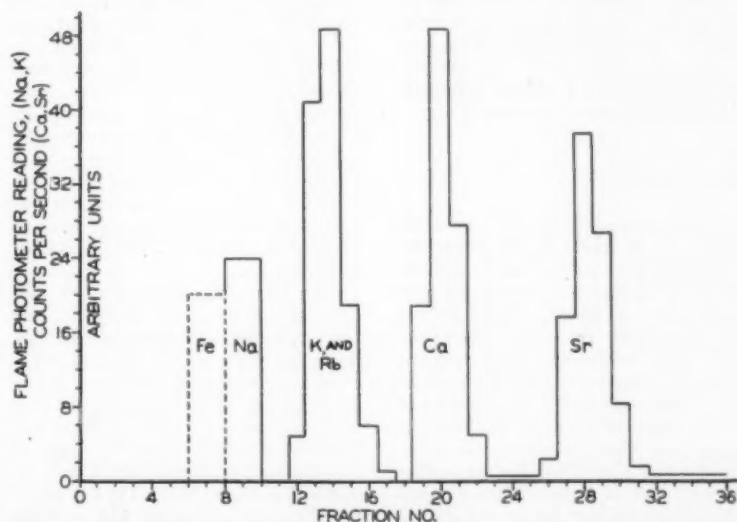


Fig. 2. Separation of strontium from 130-milligram sample of muscovite. Ion-exchange column 15-cubic centimeter volume, 20 centimeters long, Dowex 50 \times 8, 200-400 mesh resin; 2.6-milliliter fractions collected using 2.5M HCl as elutriant. Iron located visually, all others by flame photometry or assay of radioisotopes. This sample contained 2.1 micrograms of radiogenic Sr^{87} and less than 0.1 microgram nonradiogenic Sr^{87} .

Table 2. Radioactive ages of minerals from the Brown Derby pegmatite and the Quartz Creek granite, Gunnison County, Colorado. Decay constants used: K^{40} , $\lambda_c = 5.51 \times 10^{-11}$ per year, $\lambda_\beta = 4.92 \times 10^{-10}$ per year; Rb^{87} , $\lambda_\beta = 1.39 \times 10^{-11}$ per year.

Mineral	Ages in millions of years					
	K ⁴⁰ -Ar ⁴⁰	Rb ⁸⁷ -Sr ⁸⁷	U ²³⁸ -Pb ²⁰⁶	U ²³⁵ -Pb ²⁰⁷	Pb ²⁰⁷ -Pb ²⁰⁰	Th ²³² -Pb ²⁰⁸
Biotite (granite)	1320	1320				
K-feldspar (granite)	990	1490				
Zircon (granite)			930	1130	1540	530
Muscovite (peg.)	1230	1390				
Lepidolite (peg. coarse)	1320	1390				
Lepidolite (peg. books)		1410				
Lepidolite (peg. fine)	1350	1560				
Lepidolite (peg. white)	1340	1370				
Lepidolite (peg. medium)	1380	1480				
Microcline (pegmatitic)	840	1290				
Monazite (peg.)			1590	1410	1170	995
Columbite-tantalite (peg.)			1520	1470	1390	
Microcline (peg.)			915	1055	1350	

rience in the difficult procedures of separating thorium from the rare earths is not required to make a precise determination of thorium in monazite. Somewhat more complicated procedures are required for the extraction of thorium from the solution of a zircon sample, but, in principle, the methods are the same. Lead extraction from the solutions of these minerals is made quite simply with a proper preparation of dithizone and a little care in suppressing other elements that would be taken into the dithizone phase. Although the chemical procedures themselves are quite straightforward, the requirements for reagents and glassware to avoid contamination in lead analyses are probably as severe as any found in this work, because of the common occurrence of lead in building materials and motor fuel.

Already combinations of solvent extraction and ion exchange for performing difficult chemical separations have been used commercially. It is very probable that they could be combined to simplify the procedures that have been in use.

Measurements

The important results of these techniques are, of course, the measurements of mineral age that they have provided. That the mineral ages so obtained truly satisfy the conditions of reliability has been one of the chief objectives of the early stages of the work. A few results from two laboratories that have contributed significantly to the measurement of mineral ages using isotope dilution techniques are listed in subsequent paragraphs. Not every laboratory measuring mineral ages is included. Since many laboratories are just getting well started in these techniques, within a year this listing will be incomplete, even in the restricted sense that it is presented.

These measurements had their beginnings at the University of Chicago in

the laboratories of H. Brown, M. G. Inghram, and H. C. Urey. First, the work of Tilton, Patterson *et al.* (5) with the Essonville granite demonstrated that the uranium-lead and thorium-lead ages could be measured on mineral separates of a fine-grained rock. This pioneer effort provided a firm basis for the progress of the last few years with other granite separates. Later Wasserburg and Hayden (6) showed that potassium-argon ages were amenable to measurement by the isotope-dilution technique and that this method gave reproducible ages on feldspars. An important corollary to this work is the measurements reported by them on four uraninites, all of which gave $U^{238}-Pb^{206}$ and $U^{235}-Pb^{207}$ ages that agreed within 2 percent. This is convincing evidence of the unique position of pegmatitic uraninite among the uranium minerals, for no other mineral has been found that consistently gives these concordant results. The Chicago group, including Patterson (7)—who had since moved to California Institute of Technology—Wasserburg (6), and more recently Schumacher (8), has presented convincing evidence of the large gap in time between the formation of meteorites 4500 million years ago and the formation of the oldest terrestrial rocks of known age, which are 2700 million years old.

The cooperative program of the department of terrestrial magnetism and the geophysical laboratory of the Carnegie Institution of Washington has applied isotope-dilution techniques to the pertinent radioactive decay schemes in an effort to determine which of them can best be used to determine the ages of common rock-forming minerals. As a result of this study, Tilton (9) has found that the zircon analyzed by him and Patterson now seems atypical of zircon as it is commonly available in granites. A more usual pattern of ages obtained for this mineral is that shown for the Quartz Creek granite in Table 2. The two ura-

nium-lead ages for the zircon are seen to be quite discordant; hence, from these data alone, one could say very little about the age of the granite except that it was formed during the Pre-Cambrian.

In a study of pegmatitic minerals, which have often been used for the determination of ages by chemical determination of the ratio of total lead to uranium plus thorium, Tilton (10) has also found that the chemical ages on the minerals he studied are indicative of the age of the mineral only occasionally. He has found further that leaching these minerals with acid gives separation of lead with respect to uranium, and uranium with respect to thorium, that supports the pattern of ages found for the various minerals. For example, lead and uranium were leached from a uraninite with concordant uranium-lead ages in the same proportion that they were found in the total analysis of the mineral. The acid leach from the monazite in Table 2, on the other hand, showed preferential leaching of uranium with respect to thorium and of Pb^{206} with respect to Pb^{208} . Such measurements are particularly significant in testing the assumptions for reliable age determinations and are extremely helpful in understanding the complicated age pattern of the monazite.

G. L. Davis (11), L. O. Nicolaysen, G. W. Wetherill, P. M. Jeffery, and I have found the rubidium-strontium method consistent and reliable for both micas and feldspars in the same rock. The data in Table 2 on the rocks of the Quartz Creek region show this consistent pattern. It has also been found that when rubidium-strontium ages are compared with concordant uranium-lead ages from the same pegmatite, the former are invariably higher than the latter by a factor of about 1.25 when the currently accepted absolute counting value of the decay constant for Rb^{87} of 1.13×10^{-11} per year is used. From measurements on rocks (12) it would seem that $1.39 \times$

10^{-11} per year represents a better value for this constant.

Nicolaysen (13) showed that rubidium-strontium ages conformed to an intrusive relationship of rocks in Africa ranging in age from 500 to 2700 million years. In his study of the post-Damara pegmatites in South Africa, he showed that they were not related to the Kibara System, as had tentatively been suggested by Holmes.

Jeffery (14) has demonstrated the age of widely separated pegmatites in western Australia with rubidium-strontium measurements to be about 2700 million years.

Wetherill, working with Davis, Jeffery, and me, has shown that potassium-argon ages must be used with some caution. In a study (15) of seven rocks for which both the mica and feldspar were analyzed, the ratio A^{40}/K^{40} for the micas was invariably higher than that of the feldspars. Furthermore, none of the regularity in this ratio for feldspars was found which would be predicted by the work of Wasserburg and Hayden. Table 2 shows the results of such measurements on six micas and two feldspars from the Brown Derby pegmatite and the Quartz Creek granite. The consistency in the mica potassium-argon ages, along with the consistent rubidium-strontium ages for both micas and feldspars strongly suggests that the low potassium-argon age of the feldspars is due to argon leakage from the feldspar. Limited petrographic comparison of the microclines that appear to have held most of their argon with those that appear to have lost as much as half of their argon have thus far given no clue to the reason for this leakage. It may be stated that for any mica that has been studied, the ratio of the potassium-argon age to the rubidium-strontium age is very nearly a constant (16). Because of the great chemical difference between the daughters of these two isotopes, concordance of these two ages may well prove to be more significant than that of the two uranium-lead ages. Table 2 shows that it is possible to get agreement on potassium-argon and rubidium-strontium ages when no such agreement can be obtained on any of the uranium and thorium minerals that are present in the pegmatite.

A part of this study in which all of the Carnegie group has participated has included measurements on four granites

(17). The measurements are well exemplified in the data in Table 2 for the Quartz Creek granite. The rubidium-strontium and potassium-argon ages are consistent; of the uranium-lead ages on the uranium-rich mineral separates from the granite, the Pb^{206}/Pb^{207} age agrees best with these two. Even this limited sampling of granites shows the promise of the potassium-argon and rubidium-strontium methods for accurately dating large igneous intrusives.

Other groups in this country that are using these techniques on rocks may be found at California Institute of Technology, Massachusetts Institute of Technology, the University of California, Berkeley, and Columbia University. The techniques have also been taken to Europe, South Africa, and Australia by students from the University of Chicago and fellows of the Carnegie Institution of Washington.

Conclusions

At this point it is proper to consider geologic questions that have already been answered by these techniques and some that are being studied actively. First of all, potassium-argon and rubidium-strontium methods of mineral age measurement seem to be firmly established for relative age measurements and within a short time should provide reliable absolute ages. Second, it can be stated on the basis of completed measurements that the Pre-Cambrian history of the earth's crust extends beyond 2700 million years. The pegmatites that have been measured to be this old have been found in North America, Africa, and Australia, and they probably exist on all the continents. The oldest rocks in the United States that have been measured are on the south rim of the Bridger Mountains near the Wind River Canyon in Wyoming. It is an awesome experience to travel south from Thermopolis and to realize that you are passing through remnants of geologic history that encompass more than 2500 million years. It must also be remembered that these ancient pegmatites intrude geologic formations of sedimentary and volcanic rocks that themselves are the result of even more ancient processes than those in which they were formed. Thus, a period of the order of 3000 million years or more is

available for geologic processes that have formed the crust we see today.

Next, the facility to measure the absolute age of micas in igneous intrusives of Pre-Cambrian sediments will provide a method of correlating these sediments wherever they occur in much the same fashion that fossil correlation of more recent sedimentary formations is possible. A method that is independent of the lithologic characteristics and the general structure of the sediments will provide a crucial test of the validity of these criteria, which have been all that was available to the geologist. Further, any attempts to look for more subtle evidence of such things as changes in the composition of the atmosphere or origins of life itself must be fitted into a time scale of the Pre-Cambrian. It would seem that as complete a study as possible of the relationships that may be established from the measurement of mineral age are of considerable importance. Finally, the absolute time scale since the appearance of the vertebrate fossils is based on far too sketchy data and, while these data must be valued for the information they provide, the time scale is certainly not considered complete by any thoughtful worker in the field of mineral age measurement. There is every reason to expect that this new chemical-physical geology will provide data that will bear on these problems.

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Human knowledge and human power are coextensive; for ignorance of causes prevents us from producing effects. Nature can be ruled only by being obeyed; for the causes which theory discovers give the rules which practice applies.—FRANCIS BACON.

Soil as Natural Reservoir for Human Pathogenic Fungi

Libero Ajello

Medical mycologists have long been interested in questions regarding the natural habitats of human pathogenic fungi. They have been uncertain whether these organisms are obligate parasites of man and lower animals, or whether they are saprophytes that possess the specialized ability to infect susceptible persons under certain conditions.

As early as 1893, Sabouraud (1) postulated that the dermatophytes are primarily soil saprophytes on the basis of their ease of cultivation on synthetic media, vegetable matter, and especially soil. A few years later, Sabouraud (2) went on to predict that the systemic fungi would also be found to exist as saprophytes in nature. Although several decades were to elapse before saprophytism was demonstrated among the dermatophytes, the second prophesy already had come to pass, for in 1894, Sanfelice (3) had recovered *Cryptococcus neoformans* from peach juice. Previously *Aspergillus fumigatus* (4) as well as several species of *Mucorales*, (5-8) which were not yet recognized as agents of systemic mycoses, had been isolated from nonliving substrata. Since that time, an impressively large group of pathogenic fungi of medical importance has been isolated from the environment (Table 1). With knowledge that 21 pathogenic, or potentially pathogenic, fungi have been recovered from nonliving substrata, the concept that soil is the ultimate source of many of the organisms that cause mycoses commands serious attention.

Such occasional pathogens as *Aspergillus fumigatus*, *Absidia corymbifera*, *Absidia ramosa*, and *Rhizopus oryzae* are commonly recovered from soil and air and even used, in one instance, in the manufacture of food (9). The saprophytic existence of *Sporotrichum schenckii* has been established by the detection of macroscopic colonies of that fungus on mine timbers (10). *Phialophora verrucosa* has been isolated from old boards

(11), and the vegetative spores of *Histoplasma capsulatum* (12-14) and *Microsporium gypseum* have been found in soil (13).

Thanks to the pioneering work of Emmons (15), it has been demonstrated that soil surveying is one of the most fruitful means for discovering the natural habitats of the fungi that are capable of causing human disease. During the past 5 years, groups of soils collected in widely scattered geographic areas have been examined in our laboratory for pathogenic fungi. The purpose of this report (16) is to present the results obtained from that study.

Materials, Methods, and Results

Since 1950, through the cooperation of several individuals (17) and by personal collection, 1215 soil specimens have been gathered in the following areas. In the United States, 710 samples were collected in Tennessee, 79 in Georgia, 48 in Arizona, 44 in Michigan, 16 in West Virginia, 11 in Maryland, and 10 in Alabama. One hundred specimens each were obtained from the Territory of Hawaii and the Republic of Panama, including the Canal Zone; 76 samples were obtained from Nigeria, 12 from Canada, 5 from Venezuela, and 4 from Peru.

Most of these soils were examined for the presence of *Histoplasma capsulatum* and other systemic fungi by injecting the supernatant from soil suspensions intraperitoneally into mice with subsequent culturing of their livers and spleens. Dermatophytes were sought according to a procedure developed by Vanbreuseghem (18) by baiting plates of moistened soil with pieces of sterilized human hair. Details of these procedures have been described previously (19, 20).

From 1141 of the soils, through use of the mouse procedure, 73 isolates of *Histoplasma capsulatum* were obtained: 62 from Williamson County and 5 from Shelby County in Tennessee, 1 from soil gathered in the Republic of Panama, 4 from soil specimens collected in a Vene-

zuelan cave, and 1 from a Peruvian cave. *Allescheria boydii* was recovered from 19 samples, 15 from Williamson County, Tennessee, 2 from Georgia soil, and one each from material collected in the Republic of Panama and the Territory of Hawaii. *Cryptococcus neoformans* was isolated in 12 instances: 5 from Williamson County, Tennessee, 2 from Georgia as well as Alabama, and one each from Maryland, the Territory of Hawaii, and Nigeria. One isolate of *Candida albicans* was recovered from a soil sample gathered in Shelby County, Tennessee, while *Coccidioides immitis* was found in a soil specimen that was collected at the mouth of a rodent burrow in Tucson, Arizona.

By baiting 439 of the soil samples with filaments of hair, 126 isolates of the dermatophyte *Microsporium gypseum* were recovered. These positive soils had the following geographic distribution: Panama, 36; Tennessee, 30; Hawaii, 23; Georgia, 13; Nigeria, 6; Michigan, 5; Alabama, 3; West Virginia, 2; and Canada, 2. These data are summarized in Table 2.

Discussion

Surveys similar to the ones just described serve a useful function. They lead to the discovery of the natural habitats of human pathogenic fungi and to the factors that influence their growth in a given environment. By correlating such observations with the mode and extent of infection in man and other animals, effective measures for control of the mycoses may be developed.

Our surveys, although they are limited in geographic coverage and numerical scope, have served to emphasize that soil in many parts of the world harbors a wide variety of medically important fungi. However, the same array of species will not be encountered in all areas of the world, for some of these fungi have such critical ecological requirements that their geographic distribution is necessarily limited. This fact is well illustrated by *Coccidioides immitis*, whose physical and physiological requirements are such that it is known to occur solely in certain of the semiarid regions of North, Central, and South America. These factors are so restrictive that despite the widespread distribution of contaminated plant materials and products from its endemic areas and the broad dispersal of spores of this fungus by dust storms, no evidence exists to indicate that *C. immitis* has become established beyond its classic domain.

In contrast, such species as *Allescheria boydii*, *Cryptococcus neoformans*, *Histoplasma capsulatum*, *Microsporium gypseum*, and others would be expected to occur throughout the world in appropri-

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ate habitats. Thus, through use of Van-breuseghem's keratin-baiting technique, *M. gypsum* has been recovered by Fuentes (21) from Cuban soils and by Durie (22) from Australian soils; and *H. capsulatum* has been recovered by mouse passage from Mexican soils by Gonzalez-Ochoa (23).

Both negative and positive correlations exist between the prevalence of a given fungus in soil and the number of human infections caused by that organism. The basic saprophytism of *Allescheria boydii* and *Microsporium gypsum* is reflected by the contrast between their abundance in soil and the rarity of human infections caused by these two ubiquitous molds.

On the other hand, paralleling the 72-percent level of reactivity to histoplasmin among the inhabitants of Williamson County in Tennessee (24) is the frequent recovery, in soils frequented by chickens, of *Histoplasma capsulatum*, which reached 38.9 percent (Table 3). This positive correlation undoubtedly stems both from the high infectivity of this parasite, which in mice has been shown to initiate infections through a single spore (19), and from the inherent susceptibility of human beings to *H. capsulatum*.

Table 1. Pathogenic or potentially pathogenic fungi isolated from nonliving sources.

Fungus	Reference
<i>Absidia corymbifera</i>	Lichtheim, 1884 (5)
<i>A. ramosa</i>	Lindt, 1886 (6)
<i>Allescheria boydii</i>	Emmons, 1950 (33); Ajello, 1952 (39)
<i>Aspergillus fumigatus</i>	Renon, 1897 (4)
<i>Candida albicans</i>	Negroni et al., 1941 (30); di Menna, 1955 (29)
<i>C. guilliermondii</i>	Lodder et al., 1952 (40)
<i>C. krusei</i>	Lodder et al., 1952 (40)
<i>Coccidioides immitis</i>	Stewart et al., 1932 (41)
<i>Cryptococcus neoformans</i>	Sanfelice, 1894 (3)
<i>Epidermophyton floccosum</i>	Ajello et al., 1954 (42)
<i>Histoplasma capsulatum</i>	Emmons, 1949 (12)
<i>Phialophora pedrosoi</i>	Trejos, 1954 (43)
<i>Microsporium gypsum</i>	Mandels et al., 1948 (44)
<i>Nocardia asteroides</i>	Gordon et al., 1946 (45)
<i>Phialophora jeanselmei</i>	Trejos et al., 1954 (43)
<i>P. verrucosa</i>	Melin et al., 1934 (46); Conant, 1937 (47)
<i>Rhizopus arrhizus</i>	Rabenhorst, 1892 (7)
<i>R. oryzae</i>	Went et al., 1895 (8)
<i>Sporotrichum schenckii</i>	DeBeurmann et al., 1908 (48)
<i>Trichophyton mentagrophytes</i>	Muende et al., 1937 (49); Lurie et al., 1955 (50)
<i>T. rubrum</i>	Ajello et al., 1954 (42)

Table 2. Soil study data.

Locality	Sample (No.)	Pathogenic species isolated					
		<i>Allescheria boydii</i>	<i>Candida albicans</i>	<i>Coccidioides immitis</i>	<i>Cryptococcus neoformans</i>	<i>Histoplasma capsulatum</i>	<i>Microsporium gypsum</i>
Tennessee*	710	15	1		5	67	30
Hawaii	100	1			1		23
Panama	100	1				1	36
Georgia†	79	2			2		13
Arizona‡	48			1			
Michigan§	44						5
Nigeria	76				1		6
W. Virginia‡	16						2
Canada‡	12						2
Maryland‡	11				1		
Alabama	10				2		3
Venezuela‡	5					4	
Peru‡	4					1	
Totals	1215	19	1	1	12	73	120
No. of soils tested for each fungus		1,141	1,141	48	1,141	1,141	439
Percentage positive		1.7	0.08	2.0	1.1	6.4	27.3

* Only 73 tested for *M. gypsum*. † Only 44 tested for *M. gypsum*. ‡ Not tested for *M. gypsum*. § Not tested for *H. capsulatum*.

Discovery and characterization of the ecological requirements of human pathogenic fungi can result from large-scale soil-screening programs. Studies carried out in Williamson County, Tennessee, have revealed that areas frequented by chickens are especially favorable for the growth and proliferation of *Histoplasma capsulatum* (25). It was found that approximately 39 percent of soils gathered in chicken houses and chicken yards yielded *H. capsulatum*; this is in contrast to a 13.0-percent yield from soils gathered in other habitats (Table 3). In addition, it was learned that protection of the soil from the elements favorably influenced the occurrence of this fungus. Chicken-house soils were 46.2-percent positive for *H. capsulatum*, while chicken-yard soils only gave a 20.0-percent recovery (Table 4).

The predilection of *H. capsulatum* for chicken and other avian habitats has been strikingly borne out by the epidemiological studies of Emmons (11) and those of Grayston et al. (26).

It would seem, therefore, that chickens and shelter, in a manner yet undetermined, favorably influence the development of *H. capsulatum* in soil. This influence must be an indirect one, for laboratory tests and field observations indicate that chickens are not carriers of *H. capsulatum*.

This conclusion is based on failure to discover cases of histoplasmosis among chickens in Williamson County and the inability to infect chickens following injection of heavy suspensions of the tuberculate spores of *H. capsulatum* (25).

The desire to determine what indirect influence, if any, that chickens exert on

the growth of this fungus in soil prompted two types of investigations: (i) chemical and physical analysis of positive and negative soils (27) and (ii) a comparative study of the mycoflora of soils that yield *H. capsulatum* and of soils that are negative for this mold.

Physical and chemical analysis of a group of 100 soils revealed that chicken area soils were more acid than negative soils and, as expected, had a significantly higher organic carbon content and moisture-holding capacity than soils from other habitats. It may be postulated that these and other properties of chicken-contaminated soils may create an environment more favorable for the growth of *H. capsulatum* than occurs in other types of soils. It is well known that the number and kinds of microorganisms occurring in a soil are determined, to a large extent, by the nature of the soil itself.

Table 3. Influence of habitat on occurrence of *Histoplasma capsulatum* in Williamson County, Tennessee soil. Data are derived from a group of soil specimens collected for chemical analysis.

Habitat	Samples (No.)	Recovery of <i>H. capsulatum</i>	
		Positive samples (No.)	Positive (%)
Chicken areas	54	21	38.9
Other	46	6	13.0
Total	100	27	27.0

An analysis of the mycoflora of chicken-area soils and that from non-chicken habitats has been initiated in an effort to determine what role competition among soil fungi may play in influencing the occurrence and development of *H. capsulatum* in soil. It remains to be seen what this type of study will reveal.

Agents other than chickens, however, must play a role, for the geographic distribution of *H. capsulatum* does not parallel that of poultry. Basic soil types as postulated by Zeidberg (28) may have some bearing on this matter, but the problem is very complex and its solution does not seem to be imminent.

The recovery of *Candida albicans* from the grounds of an abandoned house, di Menna's isolations from several New Zealand soils (29) and Negroni's original isolation from decaying vegetation (30) indicate that this yeastlike organism may exist as a saprophyte in nature. Since *C. albicans* is thought to be a part of the normal flora of the body of human beings and other animals, whether it exists passively in soil following introduction by animal carriers, as di Menna (29) has speculated, or whether it actually grows in soil, is a question still to be determined.

Isolation of *Cryptococcus neoformans* from soils collected in four states of the United States, Nigeria, and Hawaii indicates that this unicellular fungus has a wide distribution in nature and probably is a normal component of the soil's mycoflora. The basis for such a belief was provided by Sanfelice in 1894 (3) and was confirmed by Emmons in 1951 (31).

Analysis of the nature of the sites from which *Cryptococcus neoformans* was isolated reveals that eight came from chicken areas, one from a pigeon nest (32) and one each from the edge of a pond, a barn, and a tractor shed. Our isolations, however, are too few in number to enable us to determine what significance to give, if any, to the preponderant recovery of *C. neoformans* from

bird sites. It should be borne in mind, however, that Emmons (11) has found *C. neoformans* to be unusually prevalent in pigeon droppings.

Convincing proof is on hand that *Allescheria boydii*, one of the common causes of mycetomas and rare cases of systemic disease, is widespread in nature. It has not only been recovered during the course of our studies from the localities previously mentioned—Tennessee, Georgia, Hawaii, and Panama—but Emmons (33) discovered it in Maryland and Virginia soils, and Cain (cited by Emmons, 11) considers it to be of common occurrence in Canadian soils. Cooke (34) has frequently isolated *A. boydii* from a polluted stream in Ohio as well as from several sewage treatment plants. It is not surprising, therefore, that spores of this organism have been recovered from the air by Morrow (cited by Emmons, 11) in Texas and that it appeared as a contaminant in a culture tube observed by Adams (35) in South Carolina. The wide distribution of airborne spores of the organism undoubtedly accounts for Blank's (36) isolation of this organism from ear scrapings.

It is truly remarkable that only one dermatophyte, *Microsporum gypsum*, is regularly isolated from soil. The ease with which dermatophytes grow in soil under laboratory conditions, as well as the recovery of several species of *Trichophyton* and *Epidermophyton floccosum* from inanimate substrata, encourages one to believe that these too may exist as saprophytes in nature. Yet these species, as well as others of the genera *Trichophyton* and *Microsporum*, remain elusive. It may be that these keratinophilic fungi have become so specialized in their growth requirements that they can survive and maintain themselves only on living animal hosts; or are suitable techniques lacking with which to detect and isolate them from the environment? In time, most, if not all, of the fungi that cause human disease will probably be found to be soil saprophytes.

Knowledge about where these fungi exist in nature and how they interact with the chemical, physical, and microbiological elements of their environment should provide information applicable to the control of the mycoses. Already during World War II, the armed forces were able to reduce the incidence of coccidioidomycosis among trainees in the endemic areas by instituting dust-control measures (37). It should be possible to prevent acute epidemics of histoplasmosis by disseminating information concerning the infectivity of soil and debris from chicken and pigeon habitats (38).

It is obvious that an ecological approach to the science of medical my-

cology promises to provide not only knowledge regarding the habitats of human pathogenic fungi, but also the basis for the development of rational control measures.

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Table 4. Influence of shelter upon the occurrence of *Histoplasma capsulatum* in soil.

Source of sample	No. of samples	Isolations of <i>H. capsulatum</i>	
		No.	(%)
Chicken house	39	18	46.2
Open chicken yards	15	3	20.0
Under house	26	5	19.2
In open	15	1	6.7
Under barn	3	0	
Other	2	0	
Total	100	27	27.0

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Roy W. Miner, Naturalist and Marine Biologist

The thin and thinning ranks of invertebrate zoologists were further depleted by the death on 13 December 1955, of Roy Waldo Miner, curator emeritus of marine biology at the American Museum of Natural History and editor of the publications of the New York Academy of Sciences.

Dr. Miner's background and training provided the basis for the accomplishments of his mature years. Endowed with stamina derived from pioneer New England ancestors, he was born at North Adams, Massachusetts, 24 February 1875. A studious and diligent boy, he was graduated from the Drury Academy in 1893 and from Williams College in 1897. As an undergraduate he was elected to Phi Beta Kappa, and 30 years later his alma mater awarded him the degree of doctor of science *honoris causa*. Meanwhile, he had completed the requirements for the degree of doctor of philosophy, which he received from Columbia University in 1923.

On graduation from college, he entered the General Theological Seminary in New York, from which he was graduated in 1900. At that time he chose to be a teacher rather than a clergyman, but his classical education and training in homiletics were to prove of inestimable value throughout his life. He taught Latin and biology at the Berkeley School in New York from 1900 to 1904, when he became instructor and associate headmaster at the Kelvin School in New York.

An ardent student of nature, his interest in biology led to association with members of the American Museum of Natural History, and, in 1905, at the in-

itation of the director, the late Herman C. Bumpus, he joined the staff of the museum as assistant curator of invertebrate zoology. For the next 38 years, his talents were devoted to research and to the preparation of educational exhibits, which both instructed and delighted the multitudes that thronged the halls of the museum. He was associate curator, 1917-21; curator of living invertebrates, 1922-43; and curator emeritus since 1943.

To obtain ideas and material for the realistic, accurate, and artistic reconstructions that he designed for the museum, Dr. Miner made repeated trips to the Bay of Fundy, the wharves and tidepools of New England, and the coral reefs of the Caribbean and the South Pacific. His careful and detailed notations, both written and photographic, provided the information for precise and colorful reproductions of marine life as viewed through the eyes of a trained observer. Forty tons of coral from the West Indies was built into the framework of the Hall of Ocean Life, and smaller but equally charming and accurate exhibits portrayed the plants and animals in the tidepools and on the wharf piles of New England. He designed and supervised the construction of many invertebrate groups, aided by the loyal and enthusiastic cooperation of talented workmen who made models of many kinds, from individual protozoans to gargantuan reproductions of the life of a coral reef.

On his retirement from the staff of the American Museum of Natural History, Dr. Miner began to edit the publications of the New York Academy of Sciences. For 12 years his careful supervision and critical judgment have stamped the is-

ssues of the *Annals* and *Transactions* of the academy and the parts of the *Scientific Survey of Puerto Rico* and the *Virgin Islands*, published since 1943. He did this work as an unpaid officer of the academy, the welfare of which was one of his dearest concerns.

In addition to his contributions as curator of marine life at the American Museum of Natural History and editor of the publications of the New York Academy of Sciences, Dr. Miner published many magazine and journal articles, reports of expeditions, and books on natural history. Among the more important may be listed: *Animals of the Wharf Piles* (1912), his dissertation on *The Pectoral Limbs of Eryops and Other Primitive Tetrapods* (1925), *Diving in Coral Gardens* (1933), *The Kingdom of the Tides* (1934), *Exhibition Halls of the American Museum of Natural History* (1939), and his beautifully illustrated *Field Book of Seashore Life* (1950), which depicts the invertebrates of the Atlantic Coast of North America.

The central theme of his writing and of his designs for groups in the American Museum was the idea of evolution in nature; this was expressed particularly in the arrangements for Darwin Hall. For him, the interrelations of plants and animals were not haphazard associations but the meaningful result of the ecological factors whose operation had determined the development and character of each biotic area. His concept of unity in nature, his belief in the virtue of goodness and the triumph of right, his simple and straightforward honesty, integrity, kindness, generosity and fine sense of humor were significant manifestations of his character and personality.

Dr. Miner was a member of Sigma Xi, and fellow of the New York Academy of Sciences, the New York Zoological Society, and the Consular Law Society. He was a friendly man, who enjoyed the company of his associates and the conviviality of social affairs. His passing has removed a meticulous scholar, a fine gentleman, and a loyal friend. The world is richer because of his contributions.

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News of Science

Hydrogen Emissions from Distant Galaxies

David S. Heesch, astronomer at Harvard University, has announced the first detection of hydrogen emissions from very distant galaxies. Using the Harvard Observatory's 24-foot radio telescope, he has found hydrogen emissions from the Coma cluster of galaxies, 75 million light years from the Milky Way, the earth's star group.

Through study of hydrogen radiations from galaxies, astronomers can gain new data bearing on the evolution and structure of the cosmos. The amount of gas in a galaxy is believed to bear a relation to the galaxy's age.

The invisible clouds of neutral atomic hydrogen in our galaxy and in others emit radiations of 21-centimeter wave length. Heesch found that the 21-centimeter radiations from the Coma cluster shifted in frequency according to the expected red shift. (The farther away the source, the more the waves are shifted toward longer wave lengths.)

Small radio telescopes are not powerful enough to be of great help in such research. But the Harvard Observatory's new 60-foot telescope—Heesch was speaking at its dedication—will provide much more power. The findings gained will be of great importance for knowledge of the evolution of the universe.

Secondary-School Enrollments

The AAAS Science Teaching Improvement Program has issued a report on secondary-school enrollments in the 2-year period 1953-55. The study involved 1.15 million students in 39 states and 80 school systems. It is hoped that the results are representative of the situation in the country as a whole, for if this is so, the downward trend in science and mathematics enrollments has ceased and enrollments in these courses are increasing at a faster rate than total enrollments.

Science enrollments showed slight annual increases in 47 school systems in both 1954 and 1955, rising in 1955 to 55.8 percent of the year's enrollment. In 1953 the mathematics enrollment in

these same school systems was 50.4 percent of the total enrollment (470,477 students), and in 1955 the percentage rose to 51.6 percent (494,947 students). These increases were in addition to an over-all increase in enrollments of 5.2 percent (24,470 students) during the 2-year period.

Of the 80 school systems, those that showed the greatest increase in science enrollments in 1955 over 1953 are Little Rock, Ark., which had a 33.5 percent increase within a student population of 2593; Muncie, Ind., 47.6 percent increase and 1870 students; Fort Thomas, Ky., 39.2 percent increase and 400 students; Bangor, Me., 33.6 percent increase and 486 students; Oneida, N.Y., 56.3 percent increase and approximately 250 students; Grand Rapids, Mich., 50.5 percent increase and 645 students; and Platteville, Wis., 52.7 percent increase and approximately 500 students.

The schools that had a large percentage of increase in mathematics enrollments included Midwest City, Okla., 86.7 percent increase and 790 students; Belleville, Ill., 79.6 percent increase and approximately 1500 students; Opelousas, La., 48 percent increase and 486 students; Tampa, Fla., 43.7 percent increase and approximately 2000 students; Omaha, Neb., 35.7 percent increase and approximately 1500 students; Fort Thomas, Ky., 34.9 percent increase and 400 students; New Albany, Ind., 32.1 percent increase and approximately 1800 students; and El Centro, Calif., 30.3 percent increase and 1080 students.

Nine of the 80 school systems reported a decrease in the number of science enrollees between 1953 and 1955. The decreases ranged from 3 fewer students in Harrisburg, Pa., to 583 fewer in Philadelphia, with a total enrollment decrease of 899 science students.

Ten of the 80 school systems reported a decrease in the number of mathematics students. The total decrease was 1290 mathematics students; this loss ranged from 655 less in New York to one less in Beloit, Wis.

Only 14 schools sent data on enrollments in individual science courses, and in these the total enrollment increased by 8.4 percent during the 2 years. The percentage of those taking biology was

the same in 1955 as in 1953, but physics enrollments increased by approximately 17.5 percent, chemistry enrollments increased by 22.4 percent, and general science enrollments increased by 24.1 percent. Although the number of students (122,673) is small in this group, it is interesting that physics, chemistry, and general science enrollments rose more than twice as fast as total enrollments, while biology held its 1953 position.

In mathematics, geometry enrollments in 8 schools were up an average of 12.4 percent, trigonometry enrollments in 4 schools were up 17.9 percent, and in all 14 schools algebra enrollments were up an average of 29.6 percent. While these reports indicating small increases in the percentages of secondary-school students interested in science and mathematics are encouraging, it is obvious that much remains to be done if the anticipated scientific-personnel needs of the next decade are to be met.—I.E.W., J.R.M.

Legendary Thai Tribe

A tribe of Thai nomads that were formerly thought to be only legendary were found by an American Museum of Natural History expedition that has just returned from Thailand. The group, which was led by Robert W. Weaver, spent more than 2 years in the interior of Thailand making a survey of the distribution of the minor ethnic groups that inhabit the remote wilderness areas. Weaver was accompanied by geographer Thomas L. Goodman, a Thai interpreter, and several bearers. Elephants, ponies, and donkeys were used to help carry equipment.

Weaver reports that the high point of the trip was the meeting with the Phi Thong Luang, or the "Spirits of the Yellow Leaf." The expedition had heard many tales about a strange tribe of nomads whose women had never been seen and who were able to fade away at the approach of hunters. These primitive people earned their name because it was believed that they deserted their lean-tos when the leaves used as cover turned yellow. After many weeks of walking through hot, arid bamboo thickets and dense jungles, the party finally met two members of the Phi Thong Luang who agreed to lead the expedition to the campsite of their clan.

Only eight Phi Thong Luang still survive—six men, one woman, and a small boy. Through pantomime and the limited use of the Laotian dialect, the museum group discovered that the rest of the women and children had been killed by tigers. Weaver comments:

"Our first strong impression was of a deep feeling of melancholy that seemed

to pervade these people. Our gifts and food, though highly valued, were received with little display of emotion. During the time we were with the clan seldom did even the suspicion of a smile cross their faces. They never once raised their voices in anger, fear or joy. They seemed to talk among themselves only when the necessity arose. Their life was indeed one of basic, joyless existence."

The tribe leads the most primitive life possible. The members wear few clothes, although the nights are very cold. They know nothing of agriculture or trapping and depend solely on hunting and food gathering for their food supply. At night the Phi Thong Luang do not sit around the camp fire telling folktales or stories of the day's happenings as many primitive groups do. The child has no toys and the adults do not engage in competitive sports.

All members of the group are suffering from malaria and yaws. The woman is particularly ill, and although the expedition treated her with modern drugs, her chances of survival are poor and the tribe seems destined for extinction.

New Associate Society of AAAS

The Society for Industrial and Applied Mathematics is a nonprofit corporation organized in April 1952 and is dedicated to the applications of mathematics. Formation of the society was first considered in late November 1951, and three general meetings were held in Philadelphia early in 1952. Speakers at these meetings were W. F. G. Swann, director of the Bartol Research Foundation; Mina Rees, presently dean of Hunter College, then director of the mathematical sciences division of the Office of Naval Research; and William E. Bradley, codirector of research, Philco Corporation. The enthusiastic response at these early meetings encouraged the organizers of the society to incorporate and to initiate plans for the next year.

Objectives of the society are (i) to further the application of mathematics to industry and science, (ii) to promote basic research in mathematics leading to new methods and techniques useful to industry and sciences, and (iii) to provide media for the exchange of information and ideas between mathematicians and other technical and scientific personnel.

Society activity includes section meetings, national meetings, and technical publications. There are two sections of the society in Pennsylvania, two in California, one in Massachusetts, one in Maryland, and one in New York. Other sections are being formed. Sections of the society sponsor meetings of local interest. The first national meeting of the

society took place in Pittsburgh in 1954 at the annual meetings of the American Mathematical Society and the Mathematical Association of America. An active program of national meetings is being planned for the future.

The society sponsors several publications. These include a monthly newsletter and a quarterly technical journal. In addition, a series of monographs is being planned. A recent issue of the newsletter included the full text of an important address by M. H. Trytten, director of the Office of Scientific Personnel—"Science and engineering in the U.S.S.R. and U.S.A.: a comparison and appraisal." The first monograph of the society is a report prepared by F. J. Weyl, director of the mathematical sciences division of the Office of Naval Research entitled "A survey of training and research in applied mathematics in the United States." This timely report was prepared for the National Research Council under contract with the National Science Foundation. It surveys the present areas of mathematical research in the United States and it presents the results of a questionnaire on mathematical training that was circulated to many of the large universities.

The journal of the society contains both research papers and expository papers, but the emphasis is largely on the latter. The editors require that accepted papers have clear presentation and good exposition. In every case it is intended that the papers be easily read by a large audience and that adequate background be given so that the paper is more readily understood. Many of the papers may be considered teaching papers.

National officers of the society are John W. Mauchly, Remington Rand UNIVAC Division, president; Thomas M. Southard, Numerical Analysis Research at the University of California at Los Angeles, vice president; John W. Tukey, Princeton University and Bell Telephone Laboratories, vice president; Donald B. Houghton, Franklin Institute Laboratories, secretary; and Robert Bickel, Drexel Institute of Technology, treasurer. I. E. Block, Burroughs Corporation, is director of the society's publications committee. George W. Patterson, University of Pennsylvania, represents the society in the division of mathematics of the National Research Council.

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New Calorimeter

A bunsen-type calorimeter that can accurately measure very small quantities of heat at room temperature has been devised by R. S. Jessup of the National

Bureau of Standards. Designed for investigating the basic thermodynamic properties of high polymers, this calorimeter is particularly suited to measurement of heats of reaction, heats of solution, and heats of mixing of polymeric and other substances.

This calorimeter is similar in principle to earlier bunsen-type calorimeters, but it has been modified to permit the use of diphenyl ether instead of water as the calorimetric substance. The use of diphenyl ether has two important advantages. First, the relatively large volume changes of diphenyl ether on freezing and melting provide a sensitivity more than 3 times that of the usual ice calorimeter. Small quantities of heat can thus be measured with greater accuracy. Second, diphenyl ether melts at 26.87°C. This means that observations can be made at room temperature, and the resulting data can be readily reduced to standard temperature at 25°C. Diphenyl ether has the further advantages of being quite stable and easily prepared in a state of high purity.

News Briefs

■ New figures on the size and shape of the earth show that its radius at the equator is 3,963.26 miles. This would make the earth's equatorial circumference about half a mile shorter than the accepted estimate of 24,902.39 miles. The new figures were presented by Bernard Chovitz and Irene Fischer of the Army Map Service in a paper submitted to the American Geophysical Union.

The scientists drew their conclusions from months of field work in Africa on an expedition led by David L. Mills of the map service in 1953 and 1954. They used a Univac computer to solve problems that would have taken 10 years without the machine.

■ Research workers at Camp Detrick, Frederick, Md., recently reported to the Society of American Bacteriologists that they have made vaccines that are effective in laboratory animals against several types of botulism bacteria.

■ Ira N. Gabrielson, president of the Wildlife Management Institute, Washington, will serve as chairman of the advisory committee for the Waterfowl Research Project of the Arctic Institute of North America. Albert M. Day, former director of the U.S. Fish and Wildlife Service, heads the 2-year fact-finding project, which began last June.

The purpose of the investigation is to study the programs and policies of all land and water-use agencies that directly or indirectly affect the breeding, protection, or perpetuation of migratory water-

fowl on the North American continent. Conservationists are concerned about the future of these birds, whose habitat is gradually decreasing owing to the encroachments of agriculture and industry.

■ A report to the Inter-American Economic and Social Council of the Organization of American States recommends the establishment of an Inter-American Institute of Oceanography in the Galapagos Islands. A special committee has suggested that the institute, in addition to serving as a base for marine-life studies, could function as a weather observatory. It is estimated that the institute's initial cost would be \$1 million and that from \$300,000 to \$350,000 would be required annually for maintenance.

The Galapagos are 500 miles west of the mainland of Ecuador and are administered by that country. The islands are overrun with giant turtles, some of which weigh as much as 400 pounds. Charles Darwin studied the flora and fauna of the islands in developing his theory of natural selection.

■ Seventeen of Great Britain's largest firms have established a fund of \$4 million to aid scientific education. Assistance will take the form of capital grants for the building, expansion, and equipment of science buildings in independent schools and in other schools lacking public funds. It will assist the teaching of pure and applied science and mathematics in secondary schools.

■ North Carolina State College has been chosen as the site for the records center of the National Science Foundation's National Register of Scientific and Technical Personnel.

■ India and Canada have signed an agreement under which Canada will help finance a nuclear reactor for India. Canada will contribute about \$7.5 million of the \$14-million cost.

Scientists in the News

JOHN von NEUMANN, member of the U.S. Atomic Energy Commission, has received the Enrico Fermi award. This \$50,000 tax-free award was made in recognition of von Neumann's contributions both to the theory and to the design and construction of fast computing machines. Conferral of the award was recommended by the AEC General Advisory Committee and approved by the President.

RALPH D. LILLIE, medical director, U.S. Public Health Service, and

chief of the laboratory of pathology and histochemistry at the National Institute of Arthritis and Metabolic Diseases, left on 30 Apr. for South America. His trip is being made under the sponsorship of the Pan American Sanitary Bureau of the World Health Organization. He will visit medical schools in Lima, Santiago de Chile, Buenos Aires, Montevideo, São Paulo, Ribeirao Preto, and Rio de Janeiro. He has been invited to give short lecture courses in histochemistry in Buenos Aires and Montevideo and to present lectures at Santiago and São Paulo.

IAN TERVET, plant pathologist and operations director of the Biological Warfare Assessment Directorate at the Army Chemical Corps testing center of Dugway Proving Ground, Utah, has been named deputy for scientific activities at Dugway.

JOSEPH S. SMADEL has assumed the post of associate director of the National Institutes of Health. He was previously director of the division of communicable diseases and chief of the department of virus and rickettsial diseases at the Walter Reed Army Institute of Research.

JOHN G. SEELEY, professor of floriculture at the Pennsylvania State University has been appointed professor of floriculture and head of the department of floriculture and ornamental horticulture at Cornell University, effective 1 June. L. H. MacDANIELS, head of the department at Cornell since 1940, will retire on 30 June.

UGO FANO, chief of the nuclear physics section of the National Bureau of Standards, has been granted a Rockefeller Public Service award which will allow him to complete a book on quantum physics for nonphysicists. The award will also make it possible for Fano to accept an invitation to spend the 1956 academic year teaching at the University of Rome. He has been invited to lecture on subjects of his own choice, working in line with the university's program for developing peaceful applications of atomic energy. He plans to leave for Rome at the end of the summer.

GEORGE KELEMEN of the Harvard Medical School has been elected président général adjoint for the United States by the Haut-Collège International pour l'Etude Psychophysiologique et Psychopathologique des Langues, des Langues et de la Pensée, University of Paris, France, for the discipline of comparative anatomy and physiology of the larynx.

EDWIN PLOWDEN, chairman of the United Kingdom Atomic Energy Authority, visited atomic power reactor sites and development laboratories in the eastern United States this month as the guest of Lewis L. Strauss, chairman of the U.S. Atomic Energy Commission. Strauss visited British atomic energy research and development establishments last year.

NORBERT A. LANGE, a chemist and vice president of Handbook Publishers, Inc., Columbus, Ohio, has received the Ohio award of the Ohio chapter of the American Institute of Chemists. Lange is the publisher of *Handbook of Chemistry*.

WILLIAM B. TUCKER, chief of Medical Service at the Veterans Administration Hospital in Durham, N.C., and professor of medicine at Duke University, has been appointed director of the tuberculosis service in the VA Department of Medicine and Surgery in Washington, D.C. His appointment will become effective on 1 Sept.

DAVID E. LISTON, colonel (ret.), U.S. Army Medical Corps, has been appointed assistant director of the University of Texas M. D. Anderson Hospital and Tumor Institute. He fills the vacancy left by the retirement last September of ROY C. HEFLEBOWER, who will remain at the hospital as consultant on grants and special projects.

GEORGE K. DAVIS, head of the laboratory of animal nutrition at the University of Florida, has received the Florida award of the American Chemical Society for his work in trace-element nutrition. In 1943, radioisotope studies using radioactive cobalt were started by Davis and his coworkers, and the group gained the distinction of having carried out the first large animal studies using radioactive tracers.

HENRY F. SMYTH, JR., administrative fellow, chemical hygiene fellowship, Mellon Institute, has received the 10th annual Donald E. Cummings award of the American Industrial Hygiene Association for his contribution to industrial hygiene. Smyth directs the industrial toxicology research for Mellon Institute and also for the Union Carbide and Carbon Corporation.

W. R. RHOADS, chief staff engineer of the Georgia Division of the Lockheed Aircraft Corporation, Marietta, Ga., has been appointed director of the nuclear aircraft test laboratories to be operated for the U.S. Air Force by Lockheed on a 16-square-mile tract near Dawsonville,

Ga. He will direct the work of some 500 staff members.

FRANK A. BROWN, Jr., professor of biological sciences, has resigned the chairmanship of the department of biological sciences at Northwestern University in order to devote more time to research. The department is being administered by RAY WATTERSON (chairman) and ORLANDO PARK, professors of biological sciences, and HANFORD TIFFANY, Deering professor of botany.

OTTO A. REINKING, professor emeritus of plant pathology, New York State Agricultural Experiment Station, Cornell University, and foreign agricultural adviser for the International Cooperation Administration, has returned from Central America, where he served as field crops consultant to the U.S. Department of Agriculture and the General Services Administration. He visited Costa Rica, Honduras, and Guatemala to study abaca (Manila hemp) problems and two new banana diseases, infectious chlorosis and bacterial wilt.

GIULIO NATTA of the Istituto di Chimica Industriale del Politecnico, Milan, Italy, and CHARLES SADRON of the Centre de Recherches sur les Macromolécules, Strasbourg, France, will participate in the symposium on synthetic polymers that will take place at the University of Notre Dame, 16-17 July.

Recent Deaths

AAGE GUSMER, Summit, N.J.; 71; chemist; 1 May.

WILLIAM M. JOHNSON, Avon, N.J.; 79; mechanical engineer; 26 Apr.

R. ELMER MINTON, Huntington, N.Y.; 48; mechanical engineer; management controls administrator for Republic Aviation; 27 Apr.

PHILIP I. NASH, Brooklyn, N.Y.; 80; professor emeritus of clinical medicine at Long Island College of Medicine; 25 Apr.

LEON G. TEDESCHKE, Miami, Fla.; 78; pathologist; professor at Eclectic Medical College, 1914-29; 29 Apr.

G. EDWIN WHITE, New York, N.Y.; 52; chairman of the department of chemical engineering at City College; 2 May.

Education

■ A new radio telescope is being built at Stanford University under the sponsorship of the Air Research and Develop-

ment Command's Air Force Office of Scientific Research. The instrument, a microwave spectroheliograph, consists of 32 parabolic aluminum antennas, which will be aligned in two rows to form a cross that will occupy a 2-acre meadow. It will record solar microwave radiations in the 3000-megacycle region.

As the antennas scan the sun's surface, a photographic record of the chromosphere will be produced. A photograph of the entire solar orb will be completed in about 2 hours. Clouds will not affect antenna efficiency.

The chromosphere is a billowing layer of incandescence that rises to heights of 6000 miles above the sun's surface. Although it was discovered many years ago at the time of solar eclipses, little is known about the chromosphere. It is believed to have some connection with sunspots, which in turn are related to the magnetic storms that interrupt radio communications.

■ The establishment of a Central Index of Educational Exchangees has been announced by the Institute of International Education, New York. The index is a roster of Americans who have gone abroad and of foreign visitors who have come to the United States for educational purposes during the last 36 years. Records have been obtained on more than 210,000 persons who have studied, trained, or taught in countries other than their own during the period 1919 through 1954-55. Information on an estimated 25,000 to 30,000 new exchanges will be added annually.

The institute has published a 21-page booklet, the *Population Involved in International Education*, that describes the contents of the index and suggests its possible uses. It should be of value in research, program planning, and personnel recruitment. The index was established with financial assistance from the Ford Foundation.

■ Nine laboratory refresher courses covering the serology of syphilis, management and control of syphilis serology by the regional laboratory, and tests for syphilis using the *Treponema pallidum* will be offered at the U.S. Public Health Service Venereal Disease Research Laboratory in Chamblee, Ga., from August 1956 to May 1957. Applications for any of the courses must be signed by a state health officer or state laboratory director unless the applicant is a PHS employee. In such cases application must be approved by the medical-officer-in-charge.

Reservations are made as soon as applications are received, and lists are closed 1 month before course starting dates. Correspondence should be addressed to the Director, Venereal Disease

Research Laboratory, Division of Special Services, PHS, Box 185, Chamblee, Ga.

Grants, Fellowships, and Awards

■ Award of 28 unclassified physical research contracts with universities and private research institutions has been announced by the U.S. Atomic Energy Commission. Seven are new contracts, and the remainder are renewals.

■ The Society for Psychical Research has announced that a prize of £50 (or \$140) will be awarded for an essay of less than 3000 words on one of the following topics: (i) the best program of research for the first 100 hours of work with the next successful card-guessing subject discovered (if there is one), with the design supported by argument; (ii) the best discussion of the logical and/or scientific implications of precognition, assuming this to be established statistically from the work of card-guessing subjects.

The judges, who will be assisted by S. G. Soal, will be D. J. West, psychiatrist, London; H. H. Price, professor of logic, Oxford University; Denys Parsons, Scientific Branch, British Patent Office. Entries should be submitted under a pseudonym, together with a sealed envelope containing the entrant's actual name and address. Competitors may send in more than one entry. Papers should be typewritten with double-spacing. They must be received before 1 Oct. by the Secretary, Society for Psychical Research, 31 Tavistock Square, London W.C.1, England.

■ As a stimulant to voluntary support of medical schools—public and private—the Ford Foundation has appropriated \$10 million to match unrestricted contributions through the National Fund for Medical Education. The matching formula, designed to encourage increases in both the size of gifts and the number of contributors, will function as follows.

At the end of the calendar year, fund campaign receipts will be totaled and compared with the previous year. For every dollar of receipts up to the previous year's total, the fund will receive a specified percentage—beginning at 70 percent in 1956 and diminishing slightly each year. Everything above the previous year's total will be matched dollar-for-dollar. The first award will be made at the end of 1956 and will cover all unrestricted contributions received this year.

This appropriation, coming on top of the Ford Foundation's recent \$90-million grant to privately supported medical schools, is further recognition of the strain under which the nation's 81 medi-

cal schools are operating in striving to meet their mounting responsibilities.

In the Laboratories

■ A group of Princeton, N.J., residents who are involved in public opinion survey work has announced the formation of a concern to build a research center in Princeton that is to be known as the Princeton Research Park, Inc. Claude Robinson, president of the Opinion Research Corporation, will be chairman of the board of the new organization, which hopes to invite corporations to establish their research laboratories within the park. As soon as zoning regulations have been modified, plans will be made for the construction of the center's first two buildings: one will house Opinion Research, and the other Gallup and Robinson, an organization that conducts studies on the effectiveness of magazines and television advertising.

■ The Air Force has announced that the Convair Division of the General Dynamics Corporation will construct a new facility at Sorrento, Calif., to be used for development and production of a guided missile system. This site was selected because it is near the Air Force test site at Sycamore Canyon, and remote enough from other defense activities in the area to meet technical and strategic requirements.

The site consists of approximately 280 acres of land and buildings. It is estimated that this facility will employ as many as 6600 people by 1958. The construction of the new unit will cost approximately \$40-million.

■ An agreement has been signed between Climax Molybdenum Company and Mallinckrodt Chemical Works to submit to the Atomic Energy Commission a joint proposal for the construction and operation of a privately owned plant for the refinement of uranium compounds. The agreement further states that in the event the proposal is accepted a jointly owned company would be formed to construct and operate such facilities. Under terms of the agreement Climax would be majority owner of the resultant company.

■ The Du Pont Company has announced the formation of a British subsidiary company, the Du Pont Company, Ltd. The initial project of the new company will be to provide herbicides of British manufacture for the British market. The products involved are the substituted ureas, Telvar herbicide for industrial use and Karmex herbicide for agricultural use.

The substituted ureas are a family of

powerful and versatile biologically active chemicals, notable for their regulatory action on plant growth. Herbicidal compounds in this family are effective at low rates of application against a wide range of species of weeds. Some of them can be used for selective control of weeds where crops are growing. Du Pont has spent more than \$3 million in a research and development program in which more than a thousand of these compounds have been prepared and studied. The new company also will explore the possibility of future manufacture and sale of other Du Pont chemical products in the United Kingdom.

Miscellaneous

■ "The crisis in science education" is discussed in the June issue of *The Scientific Monthly*. The theme is explored in three articles based on papers that were presented at a symposium held during the 1955 annual meeting of the AAAS: "Current problem in perspective" by Charles Dollard, "Nation's interest in scientists and engineers" by Arthur S. Flemming, and "Role of the Federal Government in science education" by Alan T. Waterman. The June issue also contains Angus M. Woodbury's analysis of the controversy that preceded the passage of the bill for the Upper Colorado River irrigation and reclamation project, Arthur H. Robinson's article on "Mapping the land," and 11 book reviews.

■ The revised BNA anatomical terminology, prepared by an international committee with the aid of UNESCO, and approved by the International Anatomical Congress at Paris in July 1955, was adopted by the American Association of Anatomists at its recent annual meeting. The first book in which the new nomenclature has been included is apparently an *Atlas of the Human Brain and Spinal Cord* by Prof. M. Stelmasiak of Lublin, published in English by the Polish State Medical Publishers, Warsaw, 1956.

■ Two symposia on the peaceful applications of atomic energy in the fields of chemistry and biology and medicine that were originally published in 1955 by the Academy of Sciences of the U.S.S.R. have been translated into English by the Consultants Bureau. The *Symposium on Radiation Chemistry* is published in two volumes, *Action of Radiations on Water and Aqueous Solutions*, \$75, and *Action of Radiations on Individual Organic Compounds and High Polymers*, \$65. The complete symposium is priced at \$100. A translation of the *Symposium on Radiobiology* is \$50.

The Bureau is also planning to issue translation subscriptions of a new periodical, *Atomnaya Energia*, that is being published by the Soviet Academy. Six copies a year of the *Soviet Journal of Atomic Energy* will cost \$75. For information, write to the Consultants Bureau, 227 W. 17 St., New York 11.

■ The Committee on Research and Fellowships of the New York University College of Dentistry has announced openings for research investigators at the Murray and Leonie Guggenheim Foundation Institute for Dental Research. Appointments will be made in the grades of research associate, research assistant, and research fellow. Salaries are commensurate with education and experience. Further information and applications may be obtained by writing to the institute at 339 E. 25th St., New York 10.

■ The General Electric Company has presented the Smithsonian Institution, Washington, D.C., with a cluster of the company's first synthetic diamonds. During the presentation ceremony it was announced that synthetic industrial diamonds are now being produced in limited quantities at the Detroit pilot plant of G.E.'s Carbonyl Department.

■ The International Commission on Zoological Nomenclature has announced that beginning 9 Nov. it will start voting on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full details were published on 9 May in the *Bulletin of Zoological Nomenclature* (vol. 11, Pt. 11): (i) *Turbinella* Lamarck, 1799 (Cl. Pelecypoda), validation; (ii) *Terrakea* Booker (F.W.), 1930, designation of type species for, and *brachythaerus* Morris, 1845 (*Productus*), validation (Cl. Brachiopoda); (iii) *Unio* Philipsson, 1788 (Cl. Pelecypoda), designation of type species for; (iv) *Elaphe* Fitzinger, 1833 (Cl. Reptilia), validation; (v) *daca* Dampf, 1910 (*Palaeopsylla*) (Cl. Insecta), determination; (vi) *Torquesia* Douvillé, 1929 (Cl. Gastropoda), designation of type species for; (vii) Horniman (R.B.), 1940, *Preliminary Descriptions of Some New Birds*, suppression.

Comments should be sent as soon as possible to the secretary of the commission, Francis Hemming, 28 Park Village E., Regent's Park, London, N.W.1.

■ A collection of nearly 700 birds from the grasslands of Northern Rhodesia has just been sent to the Smithsonian Institution by Maj. E. L. Haydock, who has worked for several years supervising local collectors for the institution. The collection was made largely in the general neighborhood of Luanshya.

Reports and Letters

In vitro Studies on the Action of Sulfonamide Hypoglycemic Agents

It has recently been reported by several German workers (1, 2) that a simple sulfonamide compound, N-*p*-amino-benzene-sulfonyl-N'-*n*-butyl urea, referred to as BZ 55, which possesses antibacterial activity, also causes a decrease in blood sugar both in normal animals and in certain diabetic patients. These investigators have used the drug, which can be given orally, for the treatment of selected patients with diabetes mellitus. On the basis of clinical observations and animal experiments, they have suggested that BZ 55 exerts its hypoglycemic action through its effect on the alpha cells of the pancreas, the presumed source of glucagon.

In this country, a related sulfonamide, N-toluene-sulfonyl-N'-*n*-butylurea, called Orinase, has been found by workers at the Upjohn Company to have similar effects on blood sugar (3). They found that the liver-glycogen levels in rabbits that were made hypoglycemic with Orinase were the same as those in a group of untreated controls. The German workers had inferred also that BZ 55 did not cause depletion of liver glycogen (1). In view of these observations, it seemed of interest to determine whether Orinase might have some direct effect on the reactions involved in the conversion of liver glycogen to blood sugar. This communication summarizes the results of studies bearing on this problem and the results of experiments on the effect of Orinase (4) and BZ 55 (5) on the activity of rat-liver insulinase (6). It has been suggested that these drugs may inhibit the action of insulinase and thus cause hypoglycemia that is secondary to relative hyper-insulinism.

The insulinase assay system contained I¹³¹-labeled insulin (7) plus carrier insulin (8), so that the final concentration of insulin equaled 0.2 mg/ml. Tris buffer (9) pH 7.5, containing sufficient verine to give a final concentration of $10^{-3}M$ were used. Orinase and BZ 55 solutions were adjusted to pH 7.5 before addition to the reaction mixture. After incubation of the mixture for 30 min at 37°C in air, the reaction was termi-

nated by the addition of TCA, and aliquots of the supernatant were taken for counting in a scintillation counter. Concentrations of Orinase from 5×10^{-4} to $3 \times 10^{-3}M$ were tested, and no effect was observed on the activity of whole rat-liver homogenate or of a partially purified preparation of insulinase from rat liver (10). Likewise, no effect was obtained with BZ 55 at a concentration of $3 \times 10^{-3}M$.

In one type of glycogen-storage disease, liver glycogen is maintained at abnormally high levels with the occurrence of hypoglycemia, owing to a deficiency of liver glucose-6-phosphatase (11). It was conceivable that Orinase might cause hypoglycemia by interfering with the conversion of liver glycogen to blood sugar at the level of glucose-6-phosphatase. Glucose-6-phosphatase activity was determined by measuring the release of phosphate from glucose-6-phosphate as described by Cori and Cori (11). Orinase, at a concentration of $5 \times 10^{-3}M$, had no effect on glucose-6-phosphatase activity in homogenates of rat or rabbit liver.

For measurement of glucose release by liver slices *in vitro*, normal, fed animals were killed by decapitation or by bleeding from the neck. The livers were kept in an ice-cold incubation medium of pH 7.4. The medium contained, per liter,

148 mmole Na⁺, 5.3 mmole K⁺, 10.3 mmole PO₄³⁻, and 138 mmole Cl⁻. For each experiment, a series of five or six flasks (a zero time, a control with medium alone, and three or four flasks with different additions), containing successive slices from a single piece of liver, were used. Each flask contained a single, weighed slice of liver (about 100 mg) in a total volume of 5 ml. Solutions of Orinase in the medium were prepared, and the pH of these solutions was adjusted to that of the original medium. When epinephrine was used, it was added immediately after the addition of the slice. Flasks were incubated for 30 min at 37°C in air. Glucose was determined by the method of Somogyi (12), using Nelson's color reagent (13) on aliquots of the medium after precipitation of proteins with copper sulfate and sodium tungstate.

Data on the release of glucose from rat- and rabbit-liver slices incubated at 37°C for 30 min with and without $5 \times 10^{-3}M$ Orinase are presented in Table 1. There is no significant effect of Orinase on glucose formation in the absence of epinephrine. The effect of epinephrine on glucose release by liver slices is also shown in this table. The glucose released by the slice incubated in medium alone, expressed as milligrams of glucose per gram of liver, has been subtracted from the glucose released in the presence of epinephrine (8 to 10 µg/ml), expressed in a similar fashion, so that the results are presented as the effect of epinephrine on glucose release in the presence and in the absence of $5 \times 10^{-3}M$ Orinase. It can readily be seen that the effect of epinephrine on glucose release is markedly diminished in the presence of Orinase. A few similar experiments were performed using amorphous insulin as a source of glucagon activity (14). In this brief series, it appeared that Orinase also inhibits the

Table 1. Glucose formation by liver slices with and without epinephrine. (Effect of Orinase is given in parentheses in the last three columns.)

Material	Orinase $5 \times 10^{-3}M$	No. of animals	No. of experiments	Range	Mean	Standard error of mean
<i>Glucose formation</i> (milligrams of glucose per gram in liver)						
Rat liver	0	4	6	3.7-7.8	6.1	0.60
	+	4	6	5.0-7.6 (-19.3-+43.2%)	6.1 (+2.3%)	0.45 (8.8)
Rabbit liver	0	3	9	3.6-7.4	4.7	0.48
	+	3	9	3.4-7.0 (-29.8-+30.8%)	4.3 (-7.0%)	0.41 (5.6)
<i>Epinephrine effect</i> (increment in milligrams of glucose per gram in liver)						
Rat liver	0	3	5	+1.9-+4.5	+3.0	0.44
	+	3	5	+0.2-+1.7 (-32.0-+89.5%)	+1.1 (-61.9%)	0.27 (10.7)
Rabbit liver	0	3	10	+1.8-+4.4	+3.2	0.26
	+	3	10	-0.5-+2.5 (-43.2-+118%)	+0.6 (-85.7%)	0.22 (7.6)

glucagon effect under these conditions.

As Sutherland has pointed out (15), when normal, fed animals are used, changes in phosphorylase activity in the liver slices are reflected by changes in glucose output. He and his coworkers have shown that dog-liver phosphorylase is inactivated *in vitro* by liver-phosphorylase inactivating enzyme, which is a phosphatase (16), and is reactivated by dephosphophosphorylase phosphokinase, which is referred to as phosphokinase (17). He has deduced that epinephrine and glucagon may act by stimulating some portion of the phosphokinase system. If this is the case, it is suggested that Orinase may be effective in the experiments reported here by inhibiting phosphokinase, so that it cannot be activated by epinephrine or glucagon. However, there are several alternative explanations for the observed effect, including the possibility of an action of Orinase on glucose-6-phosphatase or phosphoglucomutase in the intact liver slice. Studies are now in progress to evaluate some of these alternatives and to determine whether the Orinase effect reported here is the mechanism by which it causes hypoglycemia *in vivo*. In view of the failure to demonstrate inhibition of insulinase activity by Orinase in concentrations that might reasonably be expected to occur *in vivo*, it seems unlikely that its hypoglycemic action is due to an effect on this enzyme. In addition, inhibition of insulinase alone would not easily explain the observations mentioned here on liver glycogen levels in animals given Orinase.

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6 April 1956

Intravenous Bufotenine Injection in the Human Being

Evarts *et al.* (1) found that *n*-dimethyl serotonin, or bufotenine, causes a delay in trans-synaptic transmission at the geniculate ganglion in the optic tract of the cat. When the compound is injected I. V. in the monkey, the hind legs splay out in pseudoparaplegic fashion, and the animal becomes indifferent to noxious stimuli (2). A somewhat similar clinical motor response is seen in the rat after intraperitoneal injection, plus a perseverative beating of the forepaws, as if a virtuoso were attacking a piano *fortissimo*. In the dog, I. V. administration of bufotenine in doses of 4 mg/kg causes the same pseudoparaplegic splaying out of the hind legs, salivation, pilo-motor response, an unearthly howling, which may persist for the better part of 2 hours, indifference to noxious stimuli, and apparent inability or unwillingness to defend itself when it is attacked by other dogs.

Plant preparations containing bufotenine have been used by primitive man to produce temporary ecstatic states of depersonalization and hallucination. Cohoba, the narcotic snuff of the Indians of Hispaniola and South America, was found by Stromberg (3) to contain this substance. The *mouch-more* (4) of the Koryaks and other Siberian tribes of the Kamchatka peninsula and the *flugsvamp* (5) of the Vikings, which also produced temporary psychoses, were the *Amanita muscaria* mushroom, which contains bufotenine (6). This indole is a constituent of the skin of poisonous toads and seems to be present in normal human urine in minute amounts (7).

On 12 October 1955, experiments on the I. V. injection of bufotenine were conducted at the Ohio State Penitentiary (8). Four healthy, young male convicts were used as subjects. All were above the normal intelligence level, all had been college students, none were recidivist criminals, and all were considered to be relatively stable emotionally. They were denied breakfast on the morning of the experiment.

Bufotenine (9) was dissolved in sterile, distilled water and drawn into a syringe. After venepuncture, blood was drawn into the syringe and admixed with the aqueous solution to a volume of 10 ml. This was injected slowly and steadily over a 3-minute period. The first subject received 1 mg of bufotenine in this fashion. Within 1 minute, after one-third of the injection had been completed, he complained of a tight feeling in the chest and a prickling-sensation in the face as if he had been jabbed by nettles. Before the injection was completed, he experienced a fleeting sensation of pain in both thighs and a mild

nausea. The prickly sensation in the face persisted for 6 minutes. There was no significant change in blood pressure or pulse.

The second subject received 2 mg of bufotenine over the same 3-minute period. During the first minute, he felt a tightness in his throat and a racing pulse, but objectively the pulse remained at the basic rate of 84 beats per minute. There followed a complaint of "tightness in the stomach," then a tingling in both pretibial areas. His face developed a purplish hue, and he had questionable nystagmus. Within 7 minutes after the end of the injection, all subjective complaints were gone, the facial color was normal, and no nystagmus was seen. No significant changes in blood pressure or pulse occurred.

The third subject received 4 mg of bufotenine in the afore-described fashion. Within a minute, he complained of a tingling and burning sensation in the face. In the second minute of injection, he complained of chest oppression, which quickly changed to "a load is pressing down from above and my body feels heavy." Before the injection was completed, he experienced a hollow feeling in the stomach, a numbness of the entire body, "a pleasant Martini feeling—my body is taking charge of my mind." At the time of completion of the injection, his pupils were dilated and he had bilateral nystagmus. Within a minute he reported, "I see red and black spots—a vivid orange-red—moving around." The spots changed in size and shape and persisted for 2 minutes. His face perspired and became purplish. Pupillary dilation and nystagmus were absent by the tenth minute of the experiment, but the facial color did not return to normal for 15 minutes. In retrospect, he stated that it was difficult to concentrate but that he had a feeling of great placidity during the experiment. No significant change in blood pressure or pulse occurred.

The fourth subject received 8 mg of bufotenine in the same fashion. He developed an almost immediate sensation of light-headedness as the injection began, then complained of a burning sensation in the face, which turned purple. Nausea and air hunger followed. He developed a transient hyperpnea for 30 seconds. The pupils were grossly dilated and there was moderate nystagmus. As the needle was withdrawn he blurted, "I see white straight lines with a black background. I can't trace a pattern. Now there are red, green, and yellow dots, very bright, like they were made out of fluorescent cloth, moving like blood cells through capillaries, weaving in and out of the white lines." This visual experience was present with eyes both open and closed, facial sweating and purpling was intense, nausea had abated, and the

subject felt calm. Within 2 minutes the hallucinations were gone, as was the nystagmus, and the pupils were normal in size. Eleven minutes later he said, "Even at the height of this, my mind felt better and more pleasant than usual." There was no significant change in blood pressure or pulse during the experiment.

The fifth observation was made on the second subject who had received 2 mg of bufotenine 90 minutes previously. On this occasion he received 16 mg of bufotenine I. V. Almost immediately he reported a burning sensation in the roof of his mouth. His face turned a livid purple, and he experienced generalized tingling of the body. During the second minute of injection his pupils were in wide dilation, and the ceiling of the room appeared "fuzzy" to him. During the third minute of injection he retched and vomited and stated, "My chest feels crushed." As the needle was withdrawn, marked mydriasis and nystagmus were noted. At that time, he saw red spots passing before his eyes and red-purple spots on the floor, and the floor seemed very close to his face. Within 2 minutes these visual phenomena were gone, but they were replaced by a yellow haze, as if he were looking through a yellow lens filter. Attempt to subtract serial 7's from 100 was abandoned because of many errors. His face remained deeply purple and sweating was profuse.

Nine minutes after the beginning of the experiment he stated, "Words can't come. I can't express the way I feel. My mind feels crowded." The pupils assumed normal size, but the nystagmus persisted for 30 minutes longer. At the 12th minute there was a fleeting return of the red spots before his eyes. At the 16th minute he said, "When I start on a thought, another one comes along and clashes with it, and I can't express myself clearly," and at the 25th minute, "I feel doopey but not sleepy. I feel physically tense and mentally clouded. I am here and not here." Time and space perception were grossly impaired, the yellow haze persisted, and his face remained purple. After 40 minutes he was able to report, "I feel better, but I still feel like I want to walk it off—like a hang-over." His face assumed its normal color at the end of an hour. No significant change in pulse or blood pressure occurred throughout the experiment.

These observations indicate that slow (3-min) I. V. injection of bufotenine is feasible in healthy young males in quantities as high as 16 mg without jeopardizing life, that the drug is hallucinogenic, that there is a linear progression in symptoms as dose increases, and that its effects are reminiscent of LSD₂₅ and mescaline but develop and disappear more quickly, indicating rapid

central action and rapid degradation of the drug. The presence of nystagmus and mydriasis provokes the thought that at least a portion of its effect is localized in the brainstem tegmentum. There is surprisingly little cardiovascular effect; neither systolic nor diastolic blood-pressure changes exceeded 14 mm-Hg throughout these observations, and pulse rates never varied more than 12 beats per minute. If the color of an eggplant were diluted, it would approximate the unique purple hue of the faces of these subjects, which may be due to a serotoninlike bronchiolar constriction and consequent anoxemia. Serotonin does not produce transient model psychoses of this type, but the possible role of anoxemia in the production of the hallucinogenic effects of bufotenine requires clarification. These studies will be expanded.

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7 November 1955

Stepwise Reaction via Intermediates on Separate Catalytic Centers

In heterogeneous catalysis an observed chemical reaction may take place via consecutive steps involving one or more real reaction intermediates. The term *real* shall distinguish them as existing as desorbed species in finite concentration; they may or may not be observable with given analytic methods. In porous, solid catalyst particles, the fate of such intermediates is determined by chemical kinetics as well as by the laws of diffusive transport (1). If individual reaction steps require different kinds of catalytic sites, the over-all reaction rate will be influenced by the diffusive transport velocity of the respective intermediates between such different sites. We will be interested in the ability of such a catalyst system to catalyze the over-all reaction, especially when the partial pressure of intermediates is very small.

It is possible to formulate quantitatively the requirements for geometric intimacy of the different catalyst materials to obtain an over-all reaction rate unimpeded by transport difficulties of the intermediates.

For an ordinary single step reaction, $A \rightarrow B$, following arbitrary reaction kinetics, a general condition can be derived for having the reaction rate uninhibited by diffusion effects. We shall consider a given catalyst particle (pellet, granule, or the like), with essentially all reaction sites located within the pore structure, and approximated by a sphere of radius R_0 . The rate of reaction from the entire particle per (external geometric) particle surface, dN_s/dt , must equal the net diffusive flux across its boundary

$$\frac{dN_s}{dt} = D_{eff} \text{grad } C|_{r=R_0} \quad (1)$$

where C is the reactant concentration and D_{eff} is the effective internal diffusivity. For negligible inhibition of the reaction rate by diffusion, we require a negligible internal loss of reactant concentration; that is,

$$|\text{grad } C|_{r=R_0} \ll \frac{C_0}{R_0} \quad (2)$$

where C_0 is the external reactant concentration. This condition, together with Eq. 1, results in the criterion

$$\frac{1}{3} \frac{dN_s}{dt} \frac{1}{C_0} \frac{R_0^2}{D_{eff}} \ll 1 \quad (3)$$

in which we have introduced the observed reaction rate per unit particle volume, $dN_v/dt = 3 dN_s/R dt$.

For a reaction of n th order—that is, $dN_v/dt = aC^n$ —a given internal concentration decrease will result in a smaller effect on the rate, the smaller n is, since

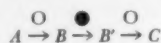
$$d \left(\frac{dN_v}{dt} \right) / \frac{dN_v}{dt} = n \frac{dC}{C}$$

However, Wheeler (2) has pointed out how even for the zero-order reaction inhibition by diffusion effects will result: The reaction rate must begin to vanish at some finite or, at least, at zero concentration; inhibition becomes noticeable when the reactant concentration at the particle center reaches such minimum or zero value. Following Wheeler's rigorous solution of the zero-order case, we can show that this condition obtains when

$$|\text{grad } C|_{r=R_0} = 2 \frac{C_0}{R_0}$$

Thus, even for the extreme case of zero-order kinetics, the condition 2 and, therefore, the theorem 3 are not altered by more than a factor of 2. We may accept this condition as sufficiently independent of detailed reaction kinetics.

A reaction $A \rightarrow C$ shall now proceed via intermediate products B and B' ,



The reaction steps $A \rightarrow B$ and $B' \rightarrow C$ proceed on catalyst type O , and the reaction $B \rightarrow B'$, on catalyst type \bullet . The catalyst consists of a mixture of porous particles of each catalyst type, having a size approximated by a spherical radius R_0 .

The reaction will now be uninhibited by diffusion transport if each reaction step fulfills the condition 3. For the steady state the reaction rate of each reaction step must equal the observed overall reaction rate of the catalyst composite dN_e/dt . Therefore,

$$\frac{1}{3} \frac{dN_e}{dt} \frac{1}{C_i} \frac{R_0^2}{D_{eff}} \ll 1; i = A, B, B' \quad (4)$$

It is obvious that it suffices to satisfy this condition for the intermediate existing at the lowest concentration. The criterion (3) demonstrates the increasing "intimacy" requirements, in terms of particle size of the catalytic components and their internal diffusivity, since intermediate species at decreasing partial pressure are relied upon for propagation of the reaction. The following will indicate some consequences of this finding.

In typical hydrocarbon reactions over oxide catalysts, the order of magnitude for the over-all reaction rate is about $dN_e/dt = 10^{-6}$ (moles per second per cubic centimeter of catalyst). (This corresponds to 50-percent conversion at a space velocity of about 1 weight of reactant per weight of catalyst per hour). The gas phase concentration C_i of any reacting species is about $10^{-5} P_{atm}$ (moles per cubic centimeter), when expressed in terms of its partial pressure P_{atm} . Condition 3 therefore becomes

$$\frac{R_0^2}{D_{eff}} \ll 30 P_{atm}$$

The diffusivity of catalyst materials can be estimated from other physical constants (2) or can be measured directly (3, 4). On a typical gel-derived oxide catalyst of about $150 \text{ m}^2/\text{g}$ surface area, we find the diffusivity at 450°C for hydrocarbon of 100 molecular weight to be about $2 \times 10^{-3} \text{ cm}^2/\text{sec}$. For this type of catalytic material and the aforementioned reaction conditions, we obtain for the critical particle size

$$R_0 \leq 0.24 \sqrt{P_{atm}} \quad (5)$$

An upper limit to the partial pressure of a proposed true intermediate is set by thermodynamics. A test for the feasibility of the reaction system can therefore be made with P_{atm} calculated from thermodynamic constants alone.

For example, at a partial pressure of the intermediate specie of 10^{-3} atm —as might apply to the thermodynamics of olefin production accompanying a hydrocarbon reaction—a maximum particle size of about 50μ would be indicated.

It is interesting to note that an intermediate specie existing at a partial pressure as low as 10^{-10} atm could propagate a heterogeneous stepwise reaction if the adjoining regions of activity are of near $100\text{-}\text{\AA}$ dimensions.

In liquid media—for example, biological systems—the afore-mentioned criteria should be applicable to reaction systems where different catalyzed processes take place in distinct but adjoining regions of volume via diffusing intermediates. With typical magnitudes for diffusivity in liquids ($D_{eff} \approx 10^{-6} \text{ cm}^2/\text{sec}$), we have, for example, for $100\text{-}\mu$ sized regions, an uninhibited reaction rate (in moles per second per cubic centimeter of space) of $10^{-2} C_i$, where C_i is the concentration of the intermediate in moles per cubic centimeter.

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3 November 1955

Convenient Method for Recognizing Nonopaque Cerium Earth Minerals

The property of discontinuous absorption of visible light by neodymium and praseodymium in nonopaque cerium earth minerals has been used by Wherry (1), Mertie (2), Adams (3), and others as a means of identifying these minerals. The very sharp absorption of yellow light (570 to $590 \text{ m}\mu$) by neodymium is especially useful and can be readily observed by illuminating the mineral with white light and looking at either the reflected or transmitted light through a visual spectroscope. Such spectroscopic observations, as well as the usual determinations of refractive indices under oils, become very tedious, however, when a large number of monazite concentrates have to be checked for contamination by similar appearing minerals, such as epidote or xenotime, or when concentrates of other minerals must be checked for freedom from monazite or other cerium earth minerals. Doubtful grains must then be carefully isolated and tested individually.

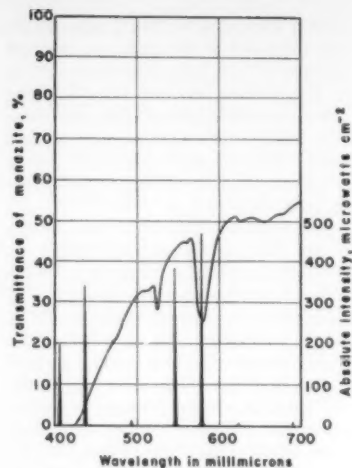


Fig. 1. The four vertical lines represent the main spectral-line emissions of a medium-pressure mercury-vapor arc in the visible region. The curve indicates the transmittance of a thin section of a monazite crystal.

The method developed (4) uses the same strong absorption of yellow light by neodymium as does the method of spectroscopic observation but in quite a different way. The sample is illuminated with the unfiltered light of a medium-pressure mercury-vapor lamp rather than with white light, and under this special light cerium earth minerals assume a characteristic emerald color, whereas other minerals undergo little change in color. A low-pressure quartz mercury-vapor lamp may also be used, provided that the purple filter, which is usually attached to such a lamp to eliminate visible radiation, is removed and a piece of ordinary glass is attached to eliminate the harmful $253 \text{ m}\mu$ ultraviolet radiation.

Figure 1 gives the optical data necessary to explain the principle of the method. The four main spectral-line radiations emitted by a medium-pressure mercury-vapor lamp (5) have been drawn at their respective wavelengths along the abscissa, and the height of the lines is proportional to their intensity of emission. The irregular curve shows the relationship between transmittance and wavelength for a thin section of a monazite crystal from Hittero, Norway, cut normal to the c -axis. This curve is typical of cerium earth minerals in general and shows a general absorption of all wavelengths shorter than about $440 \text{ m}\mu$ and the characteristic absorption of yellow light (570 to $590 \text{ m}\mu$) ascribable primarily to neodymium.

The violet radiation ($405 \text{ m}\mu$) and the blue radiation ($436 \text{ m}\mu$) of the lamp lie in the region of general absorption and

are strongly absorbed. The removal of these two radiations in this manner is not unique to cerium earth minerals, for most yellow, orange, or red minerals would do likewise. The yellow radiation (578 m μ), however, lies well within the strong absorption band of neodymium. This radiation emerges greatly weakened from a thin section or a grain of a cerium earth mineral, whereas the green radiation (546 m μ) is relatively little affected, because it lies in an adjacent spectral region of relatively high transmittance. The net result is that cerium earth minerals assume the emerald color of the unabsorbed component, whereas other minerals, more or less, retain the color that they have under white light. Non-opaque, nonmetamict cerium earth minerals are the only ones known to us that have the requisite absorption properties to produce this effect, so the test appears to be highly specific. The samples are observed directly with the naked eye without recourse to a spectroscope, thereby greatly simplifying the task of recognizing cerium earth minerals in mineral concentrates.

The principle of the method should be applicable to the identification of any mineral that has a strong, narrow band in its absorption spectrum. A light source emitting only two wavelengths of visible radiation would be devised, one wavelength being selected to lie within the absorption band and the other to lie nearby on either side of the band in a region of low absorption. The mineral would assume the color of the unabsorbed radiation.

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3 November 1955

Hemoglobin J

Previous reports have defined nine abnormal human hemoglobins that differ in their physicochemical properties, and several summaries of the literature to date are available (1, 2). Two of the abnormal hemoglobins described, H (3) and I (4) have been found to have a higher electrophoretic mobility at a pH of 8.6 than normal adult hemoglobin (5). The subject of this report is a third such hemoglobin that migrates more rapidly than normal adult hemoglobin at

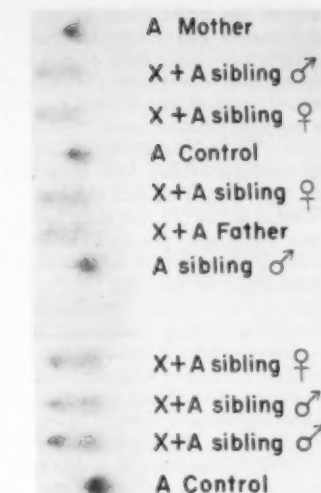


Fig. 1. Comparison by filter-paper electrophoresis of hemoglobin solutions from members of the family under study with normal control in Veronal buffer of pH 8.6 and approximate ionic strength of 0.025. Migration is to the left.

pH 8.6 but has electrophoretic properties differing from hemoglobins H and I. We propose that this hemoglobin be assigned the letter J for purposes of identification (6).

This hemoglobin was found in a young Negro female with bilateral cystosarcoma phyllodes. It was first identified by paper electrophoresis using the apparatus described by Smith and Conley (7) with Veronal buffer at pH 8.6 and approximate ionic strength of 0.025 (Fig. 1). Blood from 13 other members of the family has been examined, and the abnormality has been found in seven (Fig. 2). The father and six of nine siblings, including the propositus, had this component in addition to normal adult hemoglobin. The presence of previously described abnormal hemoglobins could not be detected. A search for the presence of the sickling phenomenon and fetal hemoglobin was unrewarding. The scatter of this family over the eastern seaboard curtailed the number of studies that could be made.

In four patients with the abnormal hemoglobin, dry smear morphology could be examined; in these instances it appeared normal. Hematocrits were obtained on all members of the family and were normal. Fragility studies were obtained in six instances of the abnormality and were normal in each case. Bilirubin was normal in the four instances in which it was obtained. None of the family had historical evidence of hematologic difficulties, and physical examination of those who were available to us failed to

reveal abnormalities that were attributable to this abnormal component.

This hemoglobin component was further studied by moving-boundary electrophoresis, and its uniqueness was established by comparison with hemoglobins H (3) and I (4), the other hemoglobins that have higher mobilities than hemoglobin A at pH 8.6. Moving-boundary electrophoretic analyses were conducted with naturally occurring mixtures of hemoglobin A with H, I, and J (8). Differences were established by comparison of the migration of the abnormal hemoglobin boundaries with that of hemoglobin A. Univalent buffers of ionic strength 0.1 were used. The buffers were as follows: pH 6.5 cacodylate, pH 7.8 barbital, pH 8.6 barbital, and pH 9.8 glycine. Each buffer was 0.08M in sodium chloride and 0.02M in the sodium salt of the buffer. At pH 6.5 hemoglobins A, I, and J migrated as cations, and hemoglobin H as an anion; at pH 7.8 and higher, all four forms migrated as anions.

In each of the buffers, the mobility of hemoglobin J was between those of hemoglobins A and I, the mobility difference between A and I being 0.6 to 0.7×10^{-5} cm² sec⁻¹ v⁻¹ and that between A and J 0.3 to 0.4×10^{-5} cm² sec⁻¹ v⁻¹. The specimen containing hemoglobins A and H was also examined in cacodylate chloride buffer of pH 6.2. The mobility difference between A and H had a large pH dependence (9), increasing from 1.0 to 2.6×10^{-5} cm² sec⁻¹ v⁻¹ between pH 9.8 and 6.2. Thus, of the four hemoglobins, A has the highest net positive charge and J, I, and H follow in order.

The electrophoretic studies showed, in addition to the mobility differences, that the carriers of hemoglobin J possessed more of the abnormal hemoglobin than hemoglobin A. This result may be discerned in the paper electrophoresis experiments shown in Fig. 1. The proportions were found to be 40 percent A and 60 percent J by moving-boundary electrophoresis at pH 6.5. The other asymptomatic carrier states for the abnormal hemoglobins are characterized by the presence of a preponderance of hemoglobin A (1).

The solubility as amorphous ferro-hemoglobin of one of the AJ samples was determined with use of the standard-



Fig. 2. Incidence of hemoglobin J in the R.B. family under study. Hemoglobin J is indicated by black, and normal hemoglobin by gray.

ized procedure described by Itano (10). In this procedure, a 50-mg sample of a hemoglobin or hemoglobin mixture is salted out at 25°C in 10 ml of aqueous solvent that is 2.58M in potassium phosphate buffer of pH 6.8 and contains 100 mg of sodium dithionite ($\text{Na}_2\text{S}_2\text{O}_4$). The concentration of hemoglobin remaining in solution is then measured. Four determinations on one of the AJ samples yielded a value of 2.00 ± 0.24 g/lit, which is significantly higher than the solubility, 1.39 ± 0.15 g/lit, found for amorphous ferrohemoglobin A under the same experimental conditions (10).

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10 February 1956

Role of Diet in Egg Development by Mosquitoes (*Aedes aegypti*)

Because of their importance as vectors of disease, the yellow fever and malaria mosquitoes have been subjected to intensive investigation for more than 50 years. Nevertheless, the nutritional require-

ments for the development of eggs in *Aedes aegypti* and *Anopheles quadrimaculatus* have never been determined. Until recently, it was generally assumed that the blood-sucking species of mosquitoes required a blood meal to mature their ova. The only studies on adult mosquito nutrition to date have been with blood fractions (1) or with supplements to blood fractions (2), but these investigations have not provided sufficient information on which to base any conclusions about the role and relative importance of such blood constituents as amino acids, lipids, carbohydrates, minerals, and vitamins. A significant difference in the number of eggs produced by mosquitoes that take blood from different host animals has been observed by several investigators, but the nutritional factors essential to the development of eggs must be known before the effect of diet on fecundity can be explained.

In a preliminary note from this laboratory, Lea *et al.* (3) reported that both *Ae. aegypti* and *An. quadrimaculatus* would ingest a skim milk and honey solution from a saturated cotton pad and would subsequently develop and lay viable eggs. In the present study (4), numerous substances in sugar solution and on saturated pads were fed to cages of 200 fertile female *Aedes* for 16 days. Although the test food was always available to the mosquitoes, no attempt was made to control the amount of food ingested or the number of insects feeding at any time. Of the foods tested, only certain proteins or their enzymatic hydrolyzates were found to stimulate egg production. Daily counts of the eggs laid over a 16-day period have been totaled for several of these foods (Table 1). Oviposition by *An. quadrimaculatus* followed the feeding of either egg albumin or proteose-peptone, the only foods tested on this species other than milk.

Although both species of mosquitoes will remain alive and vigorous for several months on a sugar solution alone, neither species has ever been known to mature eggs on a sugar diet. Therefore, it was evident that in the protein-sugar mixtures tested, protein was a major nutritional factor required for egg development and consequently for reproduction by the female mosquito.

The feeding tests were extended to include known mixtures of purified amino acids, thus affording a more accurate means of evaluating the importance of each amino acid in the diet. A medium containing 18 amino acids, dextrose and levulose, and a salt mixture was formulated, which, when fed for 14 days to cages of 400 female *Aedes*, resulted in oviposition of viable eggs. Another mixture of 12 acids (Table 2, medium A) was found to be as effective as the mixture of 18 acids. From medium A, each

Table 1. Egg production from test foods. The values represent egg production after 16 days from 200 *Ae. aegypti* females. The liquid foods contained 90 ml plus 10 ml of honey; the dry foods contained 10 g plus 10 ml of honey diluted to 100 ml with water.

Food	Eggs (No.)
Citrated (hemolyzed) beef blood	15,905
Fresh skim milk	3,072
Powdered egg albumin	9,408
Proteose-peptone	2,815
Enzymatic digest of soybean meal	1,092
Enzymatic digest of yeast	2,416
Enzymatic digest of casein	7,409
Enzymatic digest of lactalbumin	2,733

amino acid was omitted singly, and the effect on egg production was observed in the egg counts. Of the 12 acids, there were eight (arginine through valine) which, when omitted, made the medium inadequate for the development of any eggs. The omission of histidine or methionine so limited the rate of ovarian growth that only a few eggs were laid, while the omission of cystine or glutamic acid reduced oviposition to a lesser degree. Although some eggs were laid on a mixture of the eight acids alone, the best results have been obtained with a medium containing all 12 amino acids.

Tests were also made in which the concentration of each of the 12 acids was varied. The optimum quantity of each acid was then used to establish a new medium (Table 2, medium B) that enabled the mosquitoes to lay an average of 14,000 eggs in 14 days. This was twice the number laid on medium A and indicated the importance of proper balance among the amino acids in the mixture. In addition, some preliminary tests of other factors in blood showed that lipids are dispensable but that minerals may be

Table 2. Amino acid composition of test diets. Each medium also contained 5 g dextrose, 5 g levulose, 0.15 g of a salt mixture, and 100 ml of water.

Amino acid	Composition (g/100 ml)	
	Medium A	Medium B
L-Arginine	0.5	0.38
DL-Isoleucine	1.0	0.50
L-Leucine	1.0	0.75
L-Lysine	0.9	0.75
DL-Phenylalanine	0.7	1.20
DL-Threonine	0.8	0.30
L-Tryptophan	0.4	0.30
DL-Valine	1.0	1.00
L-Histidine	0.7	0.15
L-Methionine	0.2	0.15
L-Cystine	0.2	0.15
L-Glutamic acid	1.0	1.00

a factor in egg formation. At present, the role of vitamins is being studied using adults that have been reared under aseptic conditions.

In these investigations on female mosquitoes, counts of the eggs produced provided a simple means of evaluating the nutritional requirements for egg development. Although the influence of diet on growth is perhaps more often measured in the immature animal, the nutrients required by the adult, in addition to those for maintenance and body repair, are of profound importance to the survival of the species through their effect on fecundity. The adult mosquito apparently requires little or no intake of protein for maintenance; hence, a limiting nutritional factor in reproduction is the availability of protein.

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10 November 1955

Activation of Bacteriophage by Urea

Some strains of the bacteriophages T4 and T6 must first react with or be activated by certain amino acids and amino acid analogs, which are designated *cofactors*, before they can adsorb to their bacterial hosts. (1, 2). The activation process is completely reversible. The most efficient of the known cofactors is L-tryptophan, which is demonstrably active at concentrations of $10^{-5}M$ (3). The nature of the interaction between these amino acids and the phage is unknown. It is the purpose of this communication to report that urea is capable of imparting adsorbability to a cofactor-requiring strain of T4 (4). The action of urea on proteins has been extensively studied (5), and the evidence from such studies leads to the conclusion that urea exerts its effect on protein by breaking weak secondary bonds within the macromolecule, changing thereby the rigid structure of the "native" to the looser configuration of the "denatured" protein.

Activation of cofactor-requiring strain T4.38 by urea has been demonstrated by means of the following procedure. Suspensions of the phage are incubated in urea solutions that are maintained at constant temperature. After various lengths of time, the phage are diluted

out of the urea solutions into cofactor-free suspensions of 2×10^8 cells of *Escherichia coli*, strain B, per milliliter to allow adsorption of any phage activated by this treatment. After permitting sufficient time for adsorption to reach completion, the titer of adsorbed phage is then assayed by plating aliquots from the infected bacterial suspension on F agar (F agar is a cofactor-free synthetic substrate on which only those cofactor-requiring phage that have already adsorbed to bacteria before plating can form plaques, 1). Treatment with urea, however, destroys the infectivity of the bacteriophage particles as well as activating their adsorbability to bacterial cells.

To determine the titer of phage that have survived the urea treatment, aliquots of the adsorption mixture are also plated on N agar. (N agar is a nutrient broth substrate on which both adsorbed and unadsorbed cofactor-requiring particles can form plaques.) The ratio of the assays on the two types of agar, F/N, is then the fraction of phages surviving the urea treatment which have adsorbed to bacteria under our standard conditions. This fraction is the outcome of two competitive processes: adsorption and the loss of urea-conferred adsorbability that takes place when the urea is diluted away. The adsorption of a urea-treated population of cofactor-requiring phages can also be demonstrated by use of a radiolabeled stock of T4.38. After incubation in urea solutions and dilution into bacterial suspensions, as mentioned, the fraction of the activated population adsorbed can also be assayed

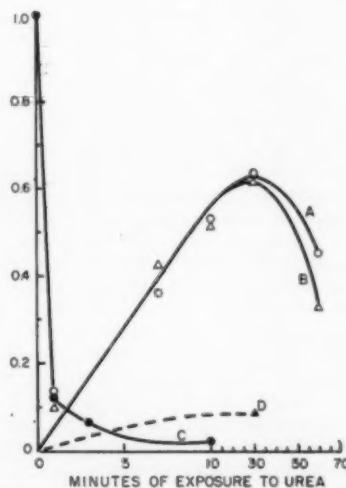


Fig. 1. A, fraction of S^{35} adsorbed to bacteria; B, fraction of survivors adsorbed to bacteria, F/N; C, fraction of survivors, N/N₀; D, fraction of S^{35} adsorbed to resistant bacterial strain, B/4.

Table 1. Activation rate constant, k , and killing rate constant, c , presented for different conditions of activation.

Conditions of activation			k	c
Urea concn. (M)	pH	Temp. (°C)		
2.5	6.5	4.5	0.0020	0.24
2.5	6.5	15	0.00017	0.02
2.5	6.5	37	0.0018	0.12
2.5	6.5	47	0.0030	0.58
2.5	6.5	0	0.14	0.92
3.0	6.5	0	0.82	3.7
2.0	6.5	0	0.0025	0.060
2.0	6.0	0	0.00027	0.0067
2.0	7.0	0	0.0075	0.30
2.0	8.0	0	0.020	1.20

by counting the fraction of the total radioactivity that is sedimentable with the bacterial cells. The results of such an experiment, in which S^{35} -labeled phage were treated with nonbuffered 2.5M urea solutions at 0°C, are presented in Fig. 1.

First of all, it may be seen from curve C that this urea treatment rapidly inactivates the phage. From curve B it is seen that, initially, the longer the phage are incubated in the presence of urea, the greater the percentage of surviving phage that are adsorbed to the bacterial cells. Ultimately, this percentage decreases with increasing incubation time. By comparing curves A and B, it may be seen that the adsorbed fraction of the surviving phage, F/N, is equivalent to the fraction of the total population adsorbed to bacteria, as measured by the amount of adsorbed S^{35} . This equivalence, it is seen, holds over a wide range of survival values. Finally, from curve D, it is seen that urea-treated phage adsorb only to a slight extent to the resistant bacterial strain, B/4. Thus these phage have retained their specific adsorption characteristics. The results of the experiment shown in Fig. 1 and of other experiments not presented here show that, initially, the ratio F/N rises linearly with time, or $F/N = kt$. The fraction of survivors, N/N_0 , can be shown to satisfy the relation, at the beginning of the inactivation, $\ln(N/N_0) = -ct$. In Table 1, the values of the rate constants, k and c , are presented that have been found on treatment of T4.38 with different urea concentrations at various pH and temperatures. It is apparent that both k and c are strongly dependent on the urea concentration, being proportional to approximately its twelfth power. Both of these constants, furthermore, are seen to be minimal at some temperature between 15° and 37°C. Finally, both k and c increase as the pH is raised from 6 to 8. An extensive similarity exists,

therefore, between the kinetics of killing and of activation of T4 bacteriophage by urea and the kinetics of protein denaturation by urea, for they exhibit entirely analogous concentration, temperature, and pH dependence.

We conclude that, through a range of values of pH and temperature, urea activates cofactor-requiring phage in a manner similar to its denaturing action—that is, by breaking critical hydrogen bonds in the protein of the phage adsorption organ to produce a new configuration, which is able to form an attachment to the bacterial surface. It seems reasonable to postulate further that tryptophan-like cofactors exert their influence in a similar manner.

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21 November 1955

Chenodeoxycholic Acid in Human Blood Serum

For many years chenodeoxycholic acid (3,7-dihydroxycholanolic acid) was thought to be confined largely to the bile of fowls and to occur only as a minor component of human bile. Recent studies (1) have shown, however, that this bile acid is a prominent constituent of human bile and that it is also one of the principal bile acids in human blood serum (2). After considering the numerous methods for measuring blood choleliths with their highly variable results, which ranged from none at all to values exceeding 100 mg percent, Sobotka (3) concluded that reliable procedures must be preceded by a reasonable amount of evidence that the bile acid being quantitated actually exists in the serum. The present study is designed to furnish some of this necessary evidence and thus to provide a basis for further quantitative studies of the several bile acids in human serum.

An extract of serum was prepared according to methods that have previously been described (4). The procedure employed was as follows: serum was removed from freshly clotted blood, and 25 ml was added dropwise to a mixture of 250 ml of ethanol and 15 ml of a saturated aqueous solution of barium hy-

drexide that contained 1 g per 100 ml of barium acetate. The mixture was heated 10 minutes in a boiling water bath, and the precipitated proteins were removed by filtering through a medium sintered glass funnel. The filtrate was taken to dryness under reduced pressure at 40° to 45°C. The dry residue was stirred with 100 ml of ethyl acetate to which 2.5 ml of a 3.3-percent solution of anhydrous calcium oxide in ethyl acetate had been added. The mixture was heated in a boiling water bath for 2 minutes; it was then centrifuged, and the supernatant was decanted. The ethyl acetate wash was repeated twice more in the same manner, except that the calcium oxide reagent was omitted. The residue was then dissolved in 10 ml of 7N sodium hydroxide and autoclaved for 3 hours at 140°C. After hydrolysis, the alkaline solution was made up to a volume of 50 ml with water, acidified with concentrated hydrochloric acid to a blue reaction with congo red paper (pH less than 3), and extracted four times with 50-ml portions of chloroform. The chloroform extract was concentrated to dryness under reduced pressure, and the residue was taken up in acetone and adjusted to a volume of 1 ml.

Paper chromatography was carried out as described by Sjoval (5) by applying 0.2 ml of the acetone solution to the paper. Solutions of cholic acid (3,7,12-trihydroxycholanolic acid), deoxycholic acid (3,12-dihydroxycholanolic acid) and chenodeoxycholic acid in acetone were also applied in amounts ranging from 1 to 40 µg to serve as controls. Antimony trichloride reagent was used for identification as previously described (6). In a system using 20-percent isopropyl ether in heptane, descending for 18 hours, a well-defined spot could be seen that moved at the same rate as the known chenodeoxycholic acid and that also had a purple fluorescence identical with that of the chenodeoxycholic acid control.

By this means chenodeoxycholic acid has been observed repeatedly in both normal and icteric serums. Cholic acid and deoxycholic acid have also been regularly found by employing 60-percent isopropyl ether in heptane. For normal serum it is sometimes necessary to apply larger amounts of the acetone solution in order to detect the minute amounts of bile acid present. If hydrolysis is not done, the bile acids occur as conjugates of glycine and taurine, and a different solvent system is required for chromatography; no free bile acids have been observed in human serum thus far.

In these qualitative studies, no attempt has been made to measure the amounts of bile acids present beyond comparing the size and fluorescent intensity of spots from serum with that of the known amounts of acids that were applied as

controls. By this process, it was observed that cholic acid and chenodeoxycholic acid occur in approximately equal amounts, the former usually predominating in normal serum. Deoxycholic acid occurred in much smaller amounts. Wysocki and associates (7) have noted that an extract of serum dissolved in a mixture of sulfuric and acetic acids had a total absorbancy at 3100 Å that exceeded the values contributed by deoxycholic acid and cholic acid at this wavelength; they concluded that the difference was due to chenodeoxycholic acid. This conclusion is supported by our findings. Their observation that the concentration of chenodeoxycholic acid is approximately 7 times that of cholic acid is probably accounted for by the differences in the methods used (8, 9).

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9. The advice of C. J. Watson and the technical assistance of J. Figen is gratefully acknowledged.

28 October 1955

Lipid Levels in Migrating Birds

Although it is generally known that the body fat content of migratory birds increases greatly at the time of migration, few actual measurements of total lipids have been made. In October 1954, we obtained a sample of birds representing many species that had been killed by flying into obstacles near airport ceilometers. On the nights of 7 and 8 October a large concentration of birds was evidently "riding a cold front" southward when peculiar weather conditions brought about accidents at a number of airports (1). Specimens frozen shortly after death were obtained for us by Dr. W. Johnston of Mercer University, Macon, Ga., and by Ivan Tomkins at Savannah, Ga. This material has enabled us to compare lipid deposition of birds that were literally "snatched from the air" during migration with previous data that were obtained from premigrant, nonmigrant, and experimental birds. In

this paper we are concerned only with the order of magnitude of lipid depositions; we have left further details of the nature and formation of the remarkable "migratory fat" for subsequent publications.

Specimens while still frozen were ground up in a chilled food chopper and then dehydrated and partially extracted in cold alcohol and ether, 3:1. The solid residue was extracted in a Soxhlet (for large species) or Bailey-Walker (for small species) extractor using petroleum ether and chloroform, 5:1. The two extracts were then evaporated to sticky dryness and reextracted together with petroleum ether, thus leaving behind the small amounts of alcohol-soluble proteins and other impurities. The total extracts were evaporated over a steam bath and dried to constant weight in a vacuum desiccator. The nonfat dry weight was also obtained. The results are given in Table 1.

Total lipids are expressed as a percentage of both total wet weight and total dry weight. All the October "ceiling" birds proved to be quite fat, with little evident difference between sexes or between first year (easily identified by incompletely ossified skulls) and older birds. The first seven species listed in Table 1 migrate south of the United States for the winter and in some cases, at least, nonstop for 500 miles or more over the Gulf of Mexico. Individuals of these species were quite uniformly fat as shown by the low coefficients of variation. On the other hand, the yellowthroats that winter partly in the southern United States and partly in the West Indies and Mexico were not only less fat than the species that travel farther but also showed greater individual variation.

In Table 2 average lipid levels of the migrating birds are compared with those of premigrant, postmigrant, and experimental birds of species of various migratory status. These data indicate that the highest levels occur just prior to or during migration in species that winter in Central or South America. In this group of "overseas migrants," a third of the wet weight or nearly two-thirds of the dry weight may be lipids, most of it in the form of huge subcutaneous and interperitoneal fat deposits. By contrast, nonmigratory species—that is, "permanent residents"—and migratory species during periods of nonmigratory activity proved to carry not more than 6 or 7 percent fat. The white-throated sparrow, which does not migrate south of the continental United States, is intermediate between these two extremes. The maximum lipid deposition that could be induced experimentally by long photoperiods in captive individuals of this latter species was almost exactly the same as

observed in wild birds that had been captured a few days prior to northward migration in the spring.

It is interesting and perhaps significant that all but one of the major parts and organs of the body increase in lipid content just before migration; the exception is the heart, which shows no increase in fat content whatsoever (2). Thus, fuel is stored in all parts of the body, but unlike the condition in obese

human beings, the heart is not hampered by an excess of fat.

The remarkable fat deposition in ruby-throated hummingbirds is of special interest, for it is thought that these tiny birds make a long overwater flight to Central America. Pearson (3) has measured the rate of metabolism of flying hummingbirds and has estimated the amount of energy needed for long flights. Having no data on fat deposition at the

Table 1. Lipid levels in a sample of birds killed while in actual migratory flight over Georgia, 7-8 Oct. 1954.

Species	No.	Avg. wet wt. (g)	Total lipids as percentage of wet and dry wt.					
			Wet wt.			Dry wt.		
			Avg.	Extremes	V*	Avg.	Extremes	V*
Black-throated blue warbler (<i>Dendroica caerulescens</i>)	16	10.6	27.6	21.6-35.7	14.3	55.5	45.6-61.9	9.0
Ovenbird (<i>Seiurus aurocapillus</i>)	16	21.7	29.7	27.4-34.1	8.0	56.8	53.5-62.2	5.6
Bay-breasted warbler (<i>Dendroica castanea</i>)	4	14.7	31.0	25.7-35.5		60.6	52.3-64.3	
Summer tanager (<i>Piranga rubra</i>)	6	39.4	37.2	32.9-41.8	8.6	66.02	62.6-70.3	3.9
Scarlet tanager (<i>Piranga erythromelas</i>)	3	37.8	33.9	30.1-37.0		63.0	58.4-66.9	
Philadelphia vireo (<i>Vireo philadelphicus</i>)	6	13.4	26.2	21.2-32.1	16.2	56.6	49.5-63.9	10.3
Red-eyed vireo (<i>Vireo olivaceus</i>)	4	20.6	28.5	22.5-32.5		58.8	51.5-65.8	
Yellowthroat (<i>Geothlypis trichas</i>)	13	10.9	22.2	11.3-31.0	32.2	48.0	30.2-62.8	22.7

* V is the coefficient of variation.

Table 2. Comparison of lipid levels in birds of various migratory status.

Species	No. of individuals	Total lipids in percentage of wet wt. (g/100 g)	
		Avg.	Extremes
<i>Overseas or long-distance migrants</i>			
Seven species of warblers, vireos, and tanagers in actual southward migration over Georgia; data from Table 1	55	29.8	21.2-41.8
Ruby-throated hummingbird (<i>Archilochus colubris</i>), premigration deposition just prior to southward migration (4)	4	43.0	40.6-45.9
Ruby-throated hummingbird during summer non-migratory period (June and July)	3	13.4	11.1-15.1
<i>Continental Migrant, the white-throated sparrow (Zonotrichia albicollis)*</i>			
Premigration deposition in Georgia just prior to northward migration in April (2)	19	16.7	9.7-24.8
Maximum deposition obtained experimentally by increased photoperiods in mid-winter (5)	22	15.7	11.8-24.5
Postmigration lipid levels after birds had reached Georgia wintering grounds in October and November (2)	23	6.8	4.3-12.8
<i>Nonmigrants (permanent residents)</i>			
English sparrows (<i>Passer domesticus</i>) and Carolina wrens (<i>Thryothorus ludovicianus</i>) in Georgia in October	17	3.5	2.1- 6.7

* *Z. albicollis* breeds in the northern United States and Canada and winters in the southern United States.

time of his publication, he estimated (on the basis of weight differences) that about 1 g of fat would be the maximum available for migration. This amount would provide energy for a flight of only about 385 miles, not enough to get the bird across the Gulf of Mexico. However, the four premigrant hummingbirds in Table 2 actually had an average fat content of 2.1 g, as compared with about 0.4 g for summer individuals. Using Pearson's metabolic rate figures, 2.1 g of fat would allow a flight of 800 miles. Even if 0.4 g (the summer level) were unavailable for flight, the remaining 1.7 g would last for 655 miles, more than enough to span the Gulf.

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9 November 1955

Effect of Foliar Sprays of Maleic Hydrazide on Photosynthesis

Maleic hydrazide (1,2-dihydropyridazine-3,6-dione) was found to decrease the number and increase the size of chloroplasts in lettuce (1). We are now able to report that this compound produces similar effects in other plants, and that there is an accompanying effect on photosynthesis.

In the experiments reported here (2) two concentrations of maleic hydrazide (MH) were used, 0.375 g/lit and 3.0 g/lit (3). Swiss chard was raised from seed in the greenhouse. In the cotyledon stage, or after the formation of two to three leaves, the seedlings were sprayed with the MH solution. Leaves that de-

Table 1. Number and size of chloroplasts in normal swiss chard leaves and in leaves treated with maleic hydrazide.

Chloroplasts	Normal	Treated	LSD ₀₁ *
No. per cell			
Palisade	73.0	42.5	19.6
Spongy			
parenchyma	81.3	57.1	21.2
Diameter (μ)	5.74	7.04	0.464

* Least significant differences at the 0.01 level of probability.

Table 2. Rates of photosynthesis and respiration and chlorophyll concentrations of normal tobacco leaves and leaves treated with maleic hydrazide.

Item	Normal	MH-treated (0.375 g/lit)	MH-treated (3.0 g/lit)
Photosynthesis (μlit O ₂ /cm ² hr)	9.17	12.08 (LSD ₀₁ = 2.14)	14.42 (LSD ₀₁ = 1.72)
(μlit O ₂ /mg of chlorophyll per hour)	1128	1928 (LSD ₀₁ = 438)	1545 (LSD ₀₁ = 441) (LSD ₀₅ = 307)
Respiration (μlit O ₂ /cm ² hr)	1.93	1.74	1.04
Chlorophyll (mg/cm ²)	0.00813	0.00636	0.00933

veloped subsequent to the treatment were used for photosynthesis studies (4). Tobacco plants were sprayed in a similar manner, except that the plants had five to six leaves at the time of treatment.

Chloroplast structure in normal and treated leaves was studied microscopically. Disks of leaf tissue were macerated in a mixture of 1N hydrochloric acid and 50 percent ethyl alcohol. Chloroplast size was determined by means of an ocular micrometer, and the number of chloroplasts per cell was determined by counting the chloroplasts in a large number of cells.

Oxygen evolution by leaf disks was measured manometrically at 25°C. Disks were punched with a cork borer, and ordinarily 10 cm² was suspended in 0.1M KHCO₃ in standard Warburg flasks. Two Lumiline tubes, supported in the bath 1 cm below the vessels, provided a light intensity of 200 ft-cd at the level of the leaf tissue. Respiration measurements made in the dark were used to correct the oxygen evolution. Dry weights of the tissue used in the vessels, or of separate aliquots, were determined by oven-drying to constant weight. Chlorophyll was determined with the Beckman DU spectrophotometer, using the method of Arnon (5).

Leaves that developed subsequent to treatment were noticeably darker green than normal leaves. The alterations in chloroplast morphology found by Callaghan (1) in lettuce were found also in swiss chard and tobacco. Representative data from one treatment are presented in Table 1. Tobacco chloroplasts are somewhat smaller than those of swiss chard, but the effect of MH is about the same as that shown in Table 1.

Rates of photosynthesis are significantly increased by pretreatment with MH, as is shown in Table 2. At the lower concentration of MH there is relatively little effect on dry weight, respiration rate, and chlorophyll concentration. The increase in the rate of photosynthesis, however, is quite spectacular. It is to this increase that we attach the most significance.

At the higher concentration, the de-

pression of respiration and the somewhat higher chlorophyll concentration account for a part of the apparent increase in photosynthetic rate. In leaf disks from plants treated with the higher concentration of MH, the dry weights per unit area were quite variable and depended on the recent history of the plants. Thus, chlorophyll or area is a better basis upon which to compare photosynthetic rates.

Swiss chard yielded values comparable to those shown for tobacco.

Maleic hydrazide has many effects on higher plants, most of which result from changes in the developmental sequence in the terminal meristem (6). At the lower concentration used here, however, there was little obvious morphological change in size or shape of leaves. The measured increase in photosynthetic rate seemed to be a modification of the physiology of the individual leaf cells. At present it is impossible to tell how the observed changes are brought about. The great change in rate per unit of chlorophyll suggests an alteration in the photochemical mechanism of photosynthesis. The low light intensity used here contributes to this suggestion. It is possible that this technique will provide an approach to the problem of energy transfer in photosynthesis.

The increase in photosynthetic rate has practical implications. Indeed, Mikkelsen *et al.* (7) found an increase in yield of sucrose from MH-treated sugar beets. However, they suggested only casually that there might be a direct effect on photosynthesis. In other experiments (8), they found increased sucrose concentration but no increase in yield.

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3 November 1955

International Comparisons of Radioactivity Standards

During the period May 1952 to November 1954, international comparisons have been made of standard samples of the radioactive nuclides Na^{24} , P^{32} , Co^{60} , $\text{Sr}^{90} + \text{Y}^{90}$, I^{131} , and Au^{198} . The organizations taking part in these measurements and comparisons have been the U.S. National Bureau of Standards, Atomic Energy of Canada Limited, and four British laboratories (the National Physical Laboratory; the Atomic Energy Research Establishment, Harwell; the Royal Cancer Hospital, London; and the Medical Research Council, London, co-ordinated through the NPL Advisory Committee on Radioactive Standards). Periodic meetings between representatives of the three countries have been arranged by the U.S. National Research Council Subcommittee on Beta- and Gamma-ray Measurements and Standards. Several papers on the work have already appeared (1-12).

The samples used for the comparisons were standard solutions prepared by the NBS, except the $\text{Sr}^{90} + \text{Y}^{90}$ and Au^{198} samples, which were prepared by the AERE. The solutions generally contained a few microcuries per gram. In the case of Co^{60} and I^{131} , stronger solutions containing of the order of 1 millicurie per gram were provided. The disintegration rates of the samples were determined at each of the laboratories by one or more of the following methods: total β counting in a 4π solid angle, $4\pi\beta\gamma$ and $\beta\gamma$ coincidence counting, and $\gamma\gamma$ coincidence counting. The results of measurements under what are considered to be the best conditions attainable at present are in agreement to within about ± 2 percent except for 4π counting of low-energy β rays.

In measurements of Na^{24} and Au^{198} by $4\pi\beta$ counting, the fractional losses of β particles by absorption are small and the results agree within ± 2 percent. They also agree within these limits with $4\pi\beta\gamma$ and $\beta\gamma$ coincidence results. The basic counting measurements for I^{131} are in agreement within 1 percent, but there

is some uncertainty concerning the allowance to be made for self-absorption. No such allowance is applied by the British and Canadian laboratories, but it has been calculated by the NBS to be about 2 percent. Owing to the complex disintegration scheme of I^{131} , there is unfortunately no ready means of providing a cross check. The apparent systematic difference of about 3 percent between the NBS results for I^{131} and the standard of this nuclide at present adopted in Great Britain and at Chalk River is thus attributable to the correction assumed for self-absorption.

Agreement to within ± 1 percent was obtained in the measurements of Co^{60} by $\beta\gamma$ and $\gamma\gamma$ coincidence counting. A wide range of values by $4\pi\beta$ counting was reported, however, by the British laboratories. Subsequent investigations at the NBS showed that owing to the relatively low energies of the β particles, the apparent disintegration rates obtained by $4\pi\beta$ counting were critically dependent on the amount of solid material in the source and on its distribution. Consideration of the Co^{60} results leads to the conclusion that owing to the precautions necessary in source preparation, and the uncertainties in the absorption corrections, the $4\pi\beta$ counting method of standardizing this nuclide is at present less reliable than the coincidence method. However, it is considered that the disintegration rate of the solution distributed was determined by the coincidence method to an accuracy approaching ± 1 percent.

Ionization chamber equipment for preserving standards of the nuclides used for these comparisons has been set up at the NBS, and similar equipment is being calibrated at the NPL. The cooperation between the NBS, AECL, and the British laboratories on all matters relating to the establishment and the maintenance of radioactivity standards is to be continued in order to check the agreement already attained and to extend the comparisons to other nuclides. It is hoped that standardizing laboratories in other countries will participate in future comparisons; those interested should write to the most convenient of the authors of this letter.

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28 November 1955

Explanation for the So-Called "Ascending Impulses" in the Pyramidal Tract

In 1953 Brodal and Kaada (1) reported responses to peripheral nerve stimulation in the medullary pyramid of the cat. They related this unorthodox finding to previous studies in which ascending fibers had been demonstrated histologically (2). The possibility that their responses were related to activity in the medial lemniscus was considered and rejected. A further evaluation of their experiments was suggested by the observation that the antidromic cortical responses to medullary pyramidal tract shocks are seriously complicated by spread of the stimulus current to the sensory pathway in the adjoining lemniscus.

In adult cats that had been lightly anesthetized with Surital, the sigmoid motor cortices and superficial radial nerves were exposed for stimulation, and the ventral medullary surface was exposed for recording. The animal was placed in a supine position, the space ventral to the medulla being filled with Tyrode's solution. Responses of medullary points were mapped following both a constant ipsilateral cortical stimulus and a maximal contralateral nerve shock.

The electrodes were 75- μ steel wires cemented together with the tips 1 mm apart. Bipolar recording proved more effective, but monopolar recording of the "active" lead against an indifferent lead in the cervical soft tissue was also used. The area adjacent to the midline was explored from the origin of the

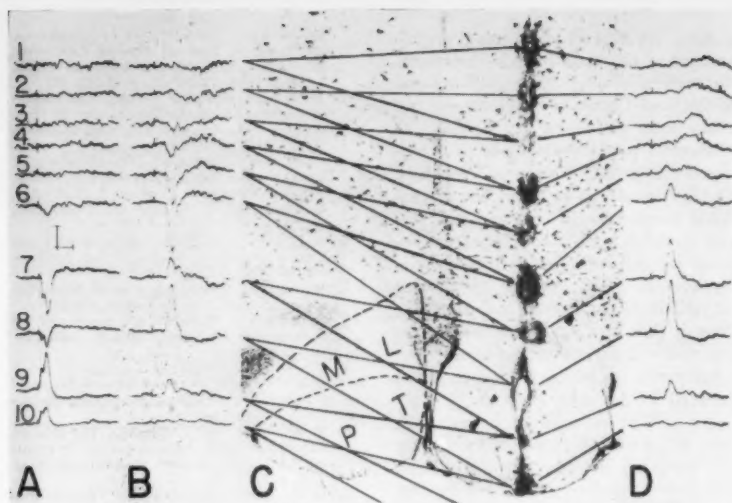


Fig. 1. (A) Bipolar recording of response to motor cortex stimulation. (B) Bipolar recording of response to nerve stimulation. (C) Lines showing recording sites in histological section; the approximate anatomical location of medial lemniscus and pyramidal tract is marked. (D) Monopolar recording of "sensory" responses as in B; upward deflection indicates relative positivity at upper electrode. Calibration 100 μ v and 5 msec.

basilar artery to the pons. Because of the toughness of the medullary pia, the electrode was usually inserted to maximal depth at the start; subsequent records from more superficial points were made at 0.5-mm intervals as it was withdrawn. All electrode tracts were identified histologically using Marshall's technique (3).

The active lead in the medulla always gave a positive response, presumably the consequence of leading from the injured regions of active axons. In every case, the response to cortical stimulus lay superficial to the area responsive to nerve stimulus (Fig. 1). Histological check revealed

that the former identifies the pyramidal tract; the latter, the medial lemniscus. Bipolar differential recording of the potential gradients gave distinctly separate reversals of the cortical and nerve-activated potentials at depths about 1 mm apart (Fig. 1A,8,9 and B,6,7). Both dorsal and ventral to the maximal lemniscus response, similar but rapidly diminishing smaller potentials could be recorded.

The small "sensory" potential in the dorsal portion of the pyramid (Fig. 1B,9) was often entirely absent at the trapezoid body where auditory fibers intervene between the diverging medial lemniscus and corticospinal tract. Nerve and cortical stimuli were given together and at various intervals when the electrode was properly situated to record both responses. The potentials always added algebraically without interaction. Reduction of shock strength at both stimulus sites resulted in a uniform fall in response at all recording positions.

In the cerebral peduncle where the medial lemniscus has moved away from the pyramidal fibers, a cortical stimulus elicited a large potential, while a nerve shock that fired somatosensory cortex produced no response (Fig. 2).

The latency of the nerve response in the medulla was about 4 to 5 msec. With monopolar recording (sometimes also with the bipolar leads), there was a subsequent slow wave at 8 to 10 msec (Fig. 1D). This could be recorded through most of the medulla and at times even in the overlying pool. It was often irregular in form, and in the dorsal reticular substance there were some related spike potentials. The late potential may be

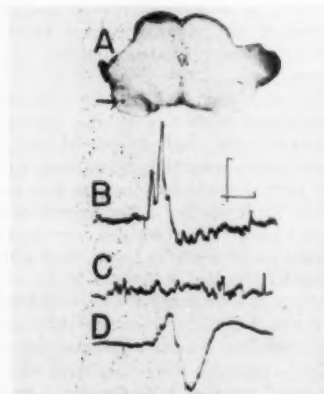


Fig. 2. (A) Recording site in cerebral peduncle. (B) Response to cortical stimulus. (C) Absent response to nerve stimulus. (D) Posterior sigmoid cortex response simultaneous with C. Calibration 100 μ v and 5 msec.

assigned to a diffuse response of the medullary gray. Occasional irregularities in shape when this wave was recorded from the pyramidal tract suggested that a descending cortical reflex response to the sensory volley might also be present. Two attempts to test this hypothesis by severing the tract at the pons were not entirely satisfactory; the response pattern did not change significantly.

From the data presented, it is reasonable to assign the potentials recorded from the pyramidal tract after sensory stimulation to current spread from the subjacent medial lemniscus. The misinterpretation of Brodal and Kaada may be explained by their exclusive reliance on monopolar recording, and by their lack of precise anatomical control of electrode placement. The results obtained do not negate the histological demonstration of ascending axons in the pyramid, although the morphological data have been questioned elsewhere (4). At this time there is no reason to qualify Sherrington's functional definition of the pyramidal tract as a descending internuncial pathway (5, 6).

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St. Louis, Missouri

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5. This work was supported in part by U.S. Public Health Service grant B-882.
6. While this paper was in press an abstract with similar conclusions became available: H. D. Patton and V. E. Amassian, *Am. J. Physiol.* 183, 650 (1955).

31 October 1955

Pluto Not a Planet?

The recent announcement of G. P. Kuiper—with the usual fanfare of a sensational magazine, radio, and TV accompaniment that we have come to expect of him—that Pluto might not be an original planet, strikes most astronomers somewhat humorously, coming, as it does, nearly 20 years after the original suggestion to this effect by R. A. Lyttleton.

In the December number of the *Monthly Notices of the Royal Astronomical Society* for the year 1936, Lyttleton published the ingenious suggestion that Pluto might have been a satellite of Neptune and that it and the present big satellite Triton might have gone through a very close approach to each other, with the result that Pluto was removed from Neptune's control and Triton turned around to become the outstanding

"wrong way Corrigan" of the solar system. But, while Lyttleton even showed how the whole thing could have happened, and also that perhaps it happened not so very long ago, astronomically speaking, it is one of those things we may never be able to prove or disprove.

It is an interesting speculation, and, in fact, at the University of Minnesota, I have regularly discussed this in class since 1937. One might even speculate further, and, as a sort of joke, suggest that if Pluto were once a moon of Neptune it might well have come through Neptune's atmosphere, which contains a lot of methane—and got covered with soot. This is not only appropriate for the god of the underworld but might explain why Pluto gives so little light. From its mass—which is not too certainly determined—we guess that Pluto should be nearly as large as the earth but, from its feeble light, it seems only a little larger than the moon. Of course, there are still many difficulties, the most outstanding perhaps being the large mass of Pluto. Most satellites are something like 10,000 times less massive than their primary (at most). Our moon is only 81.5 times smaller in mass than the earth, but if Pluto has been a satellite of Neptune, its mass is only 20 times smaller than that of its primary.

But all these are wild speculations and I am sure that they must have occurred to hundreds of others. Only scientists, in general, do not rush into print, dusting off old theories and presenting them as new.

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22 March 1956

Recombination in Bacteria

I should like to add my comments to those of J. Lederberg [*Science* 122, 920 (1955)] on the recent news report [*Science* 122, 278 (1955)] concerning recombination in the colon bacillus. In microorganisms, recombination of hereditary characters involves precisely that and nothing more. Until the mechanism of meiosis has been adequately defined, either by cytological procedures or by chromosome maps, and the existence of a standard meiotic apparatus has been established, it is not possible to determine how recombination has been achieved.

Recombination of hereditary characteristics in microorganisms may be the result of at least six different mechanisms: (i) crossing-over at meiosis, (ii) gene conversion, (iii) transduction, (iv) transformation, (v) misassortment of autonomous extrachromosomal heredi-

tary particles, and (vi) mutation induced by substrate. The last named is particularly important when the recombinants are isolated from a selective medium, as in genetical analysis of the colon bacillus. A seventh possible mechanism of recombination is mitotic crossing-over, but its demonstration depends on assumptions concerning genic stability that have recently undergone drastic revision.

Current explanations of recombination in the colon bacillus assume (i) a normal standard meiotic mechanism and (ii) a single mechanism of recombination, namely, meiotic crossing-over; deviations from the anticipated results are explained in terms of abnormalities of the assumed mechanism. In the absence of tetrad analysis, it seems necessary to withhold judgment in view of the possibility that other recombinatorial mechanisms may be involved.

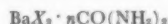
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19 March 1956

Urea Complexes of Lithium Chloride

The pharmaceutical importance of the urea addition complexes of calcium chloride and calcium iodide was first investigated by Greenbaum (1). A systematic study of the urea addition complexes of the alkaline earth halides has recently been extended by Pande and Bhatnagar (2). By use of the monovariation method (3), complexes of the general formula,



where X is chloride, bromide, or iodide and n is equal to 1/2, 1, 2, and 4 were found. Because of the similarity between the reactions of lithium salts and the corresponding alkaline earth compounds, the complexes with urea should also be of a similar nature. This was indeed found to be the case.

The complexes between urea and lithium chloride in solution were determined using the monovariation method applied to two physicochemical properties of the system, the relative viscosity and the index of refraction. A total of 23 solutions were prepared, each containing 5.10 ml of 1.967M LiCl solution and 0 to 21.00 ml of a 2.00M urea solution. Each mixture was then diluted to a total of 100 ml.

The relative viscosity of each solution was measured using an Ostwald viscometer in a water bath at $25 \pm 0.02^\circ\text{C}$. The index of refraction of each solution was measured with an Abbe refractometer at the same temperature.

The results of the viscosity measurements of each solution are shown in Fig. 1. The index of refraction curve is not shown but was of a similar appearance. From the curve, a maximum point of viscosity indicates a complex between urea and the lithium chloride in solution. It can be seen that there are three maxima in the curve, corresponding to complexes having the following compositions $\text{LiCl} \cdot \text{CO}(\text{NH}_2)_2$, $\text{LiCl} \cdot 2\text{CO}(\text{NH}_2)_2$, and $\text{LiCl} \cdot 3\text{CO}(\text{NH}_2)_2$. A complex having the composition $2\text{LiCl} \cdot \text{CO}(\text{NH}_2)_2$, was not found, as was the case with the barium halides.

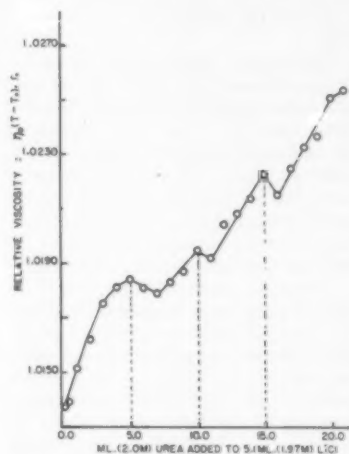


Fig. 1. Viscosity of the urea-lithium chloride system.

The nature of the bonding in these complexes is not known but is presumably an ion-dipole attraction between the metal ion and the nitrogen atoms of the urea molecule. As a consequence, the complexes are relatively unstable. In the cases where the calcium halide complexes have been isolated in the crystalline state (1, 4), it was found that they were hygroscopic and easily soluble in water but insoluble in organic solvents.

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- * Work performed at Trinity University as partial fulfillment of the requirements for the M.S. degree, 1955.

7 November 1955

Book Reviews

Progress in the Chemistry of Organic Natural Products. vol. XII. L. Zechmeister, Ed. Springer, Vienna, 1955. x + 550 pp. \$19.80.

The present volume continues to fulfill the twofold purpose of the valuable collection, which is to present the latest views and reviews on newly developed or well-explored fields written by the chief investigators themselves and to tear down the artificial barriers between organic chemistry or biochemistry and biology. Coverage by contributors from all continents extends to the following topics.

"Sesquiterpenes and diterpenes," by A. J. Haagen-Smit, Pasadena, California (43 pp., 240 references). The tectonic and comparative aspects of the compounds of this group are presented in a succinct and lucid fashion. Our understanding of the building principles of terpenes began with the oversimplified isoprene rule followed by the "biogenetic modification of this rule" (1953). The chapter ends with the challenge to apply the recently developed analytic and biochemical microtechniques to the study of isotopic terpene precursors in living systems.

"Tetracyclic triterpenes," by E. R. H. Jones and T. G. Halsall, Manchester (87 pp., 174 references). Detailed knowledge of this particular group of about 20 terpenes came to us only within the past 5 years. Lanosterol, which is contained in the unsaponifiable portion of wool fat and was suspected long ago by Windaus and Wieland to be a link in the biogenesis of sterols, is the best-known representative of the group. Shortly after its recognition as 4,4,14-trimethylzymosterol came the ingenious synthesis (1954). This chapter gives an impressive account of the development and refinement of steric analysis and stereoselective synthesis in modern organic chemistry.

"Neuere Vorstellungen auf dem Gebiete der Biosynthese der Steroide und verwandter Naturstoffe," by R. Tschesche, Hamburg (38 pp., 113 references). It is encouraging to see that the theory of the biogenesis of cholesterol and its congeners rests on firmer experimental ground than that of the lower terpenes. In fact, development in this field has been so rapid that many of the biogenetic

hypotheses reviewed or advanced in this chapter are largely of historic interest only, since the squalene \rightarrow (dihydro)-lanosterol-agnosterol \rightarrow cholesterol sequence gains experimental support.

"Some biochemical aspects of fungal carotenoids," by F. T. Haxo, La Jolla, California (28 pp., 116 references). The microbial colored polyenes, their relationship to colorless precursors or hydrogenation products (phytofluene), their role in sexual reproductive processes, inhibition and activation of chromogenesis are some of the interesting subjects taken up in this chapter.

"The Pyrrolizidine alkaloids," by F. L. Warren Pietermaritzburg, Natal (59 pp., 195 references). This exhaustive review lucidly presents the latest information on the structure, stereochemistry, and interrelationships of the unusual senecio alkaloids, in which the acid component is structurally and biogenetically as interesting as the basic moieties.

"Paper chromatography in the study of the structure of peptides and proteins," by E. O. P. Thompson and A. R. Thompson, Melbourne (57 pp., 428 references). The signal progress in the elucidation of peptides, enzymes, and hormones as a result of the separation of amino acids and peptides after hydrolysis and their identification on a microscale, using chemical marking or enzymatic selectivity, is the topic of this excellent and exhaustive review, which will serve as an indispensable guide to the techniques and methods in the field of protein analysis.

"Acides aminés iodés et iodoprotéines," by J. Roche and R. Michel, Paris (47 pp., 177 references). That this field is being reviewed for the third time in this series is ample evidence of its importance as well as of its rapid development, especially the area related to the biogenesis of thyroxine and its metabolites.

"Chemistry and biochemistry of snake venoms," by K. Slotta (48 pp., 240 references). Although enzymes, as components of toxins in general and L-amino acid oxidase, cholinesterase, phosphatases, and so on, in particular, have been reviewed repeatedly, a comprehensive and up-to-date survey of all aspects of snake venoms as presented in this chapter has been lacking.

"Gene structure and gene action," by G. W. Beadle, Pasadena (16 pp., 52 references). This continuation of the fascinating story of the promising research on biochemical genetics shows the advances made during the 7 years since the author's last review in the same series. Although it is the briefest, this is the most exciting chapter, since it moves the frontiers of science so close to the very key problems of life, gene function and reproduction. The role of deoxyribonucleic acid is discussed from various viewpoints, with due emphasis on the bold and ingenious hypotheses of Watson and Crick.

We may look forward to many more excellent volumes in this series.

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Faune de France. 59. Coleopteres Curculionides (deuxième partie). Adolphe Hoffmann. Lechevalier, Paris, 1954. 722 pp. Illus. F. 6000.

This is the second volume by Hoffmann on the Curculionidae of France. It deals with the following groups as listed in the *Junk Coleopterum Catalogus*: Alophinae; Anthonominae; Baridiinae; Ceutorhynchinae; Cleoninae—Lixini and Rhinocyllini; Cossoninae; Curculioninae; Eirrhiniinae—Acalyptini, Bagoini, and Tanysphyrini; Hylobiinae; Hyperinae; Magdalinae; Pissodinae; Raymondionyminae; Rhynchophorinae; Rhytirhininae; Trachodinae; Tychiinae; and Zygopinae.

There are recorded and described 563 species belonging to 96 genera. One species and one subgenus and many subspecies and varieties are described as new. The 438 text figures are excellent. Most are illustrations of the entire insect; at least one representative of each genus is illustrated. In some cases, male genitalia and other diagnostic characters are figured.

Keys to the tribes, genera, and species that are treated are presented, but no key to subfamilies is given, for this is in the first volume. The host plants, parasites, distribution, seasonal appearance, and relative abundance of each species are given. There is no bibliography; the references are listed after each taxonomic category with the exception of subfamilies. There is an index to subfamilies, tribes, subtribes, genera, and subgenera. The volume is paper bound and uncut, clearly printed on good quality paper.

It is interesting to note that the generic names *Hypera* and *Calendra* are used in the same sense as they are in the United States; while this usage seems to be correct, it has not been generally accepted in Europe.

Hoffmann uses *Curculio* Linn. in the sense that *Hylobius* Germar is generally used. For the nut-weevils generally known as *Curculio* Linnaeus, 1758, he uses *Balaninus* Germar, 1817, apparently overlooking Latreille's 1810 designation of a species of nut-weevil as type of *Curculio*.

Hoffmann differs somewhat from the generally accepted plan of arrangement of higher categories of Curculionidae. In this volume, he recognizes the Cleoninae, Curculioninae, and Calandrinae as subfamilies. The last two are about equivalent to Hylobiinae and the old Curculioninae, respectively. He treats as tribes groups listed in the Junk catalog as subfamilies. An interesting compromise is the use of the tribal name Bariini instead of Barini or Baridiini, the former based on *Baris*, the latter on *Baridius*.

Although the arrangement of subfamilies and tribes does not detract from the main value of the book, it tends to obscure the relationships of the French weevil fauna to that of the remainder of the world, thus making this a local faunistic work.

Hoffmann has done a fine piece of work on this very large and difficult family of beetles. In view of the damage that imported weevils can cause in the United States, this volume should be very helpful to quarantine officials and others in recognizing weevils that are accidentally introduced from France and Europe. It is hoped that the final volume on this family will soon be published.

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Chemical Methods of Blood Analysis. S. D. Balakhovskii and I. S. Balakhovskii. State Publishing House of Medical Literature, Moscow, U.S.S.R., ed. 3, 1953. 746 pp. Illus. (In Russian.)

This is a practical, well-illustrated laboratory manual carefully prepared by two outstanding Soviet clinical chemists. The procedures are clearly and logically presented and are followed by clinical interpretations. The sources of error in the various procedures are clearly indicated. All descriptions include precise presentations of methods of calculating the results and of comparing them with average standard values. The illustrations are technically excellent and include sufficient details so that a competent technician can easily comprehend and reproduce the instrumentation or procedures.

In general, the book includes descriptions of numerous modern methods of blood analysis, many of which are not available in clinical laboratory manuals

or hematology handbooks. Some notable omissions, however, should be mentioned. There is no reference to flame photometry methods of analysis of sodium and potassium, and there is no utilization of chromatography.

The book as a whole is done unusually well and is beautifully organized. The index is good. The appendix includes 16 extensive tables containing laboratory data on various blood constituents in man as well as in many laboratory animals.

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Fibrous Proteins and Their Biological Significance. Symposia of the Society for Experimental Biology, No. IX. Academic Press, New York, 1955. vi + 370 pp. Illus. + plates. \$8.

Progress in knowledge of fibrous proteins has been phenomenally great in recent years, and many of the most exciting developments are discussed in detail in this valuable book, based on papers that were presented at a symposium in Leeds in September 1954.

The opening introductory review is appropriately by W. T. Astbury, who has probably done more than any other individual to advance our knowledge of fibrous proteins. F. Sanger gives an excellent discussion of the chemistry of simple proteins, with emphasis on the determination of end groups and of amino acid sequences, including several valuable tables. E. Chargaff gives a brief, but authoritative and provocative, discussion of deoxypentose nucleoproteins. Most of the other papers deal with two great classes of fibrous proteins—the collagens and the muscle proteins.

The structural chemistry of collagens is intensively discussed by R. S. Bear, by J. T. Randall and his collaborators, and by F. O. Schmitt, J. Gross, and J. H. Highberger; the metabolism of collagen is well treated by A. Neuberger; various aspects of the biology of collagens are considered by K. M. Rudall, by D. Carlström, by A. Engström and J. B. Finean, and by S. F. Jackson and R. H. Smith; and collagen diseases are discussed by J. H. Kellgren. The structure and functions of the muscle proteins are considered by K. Bailey and S. V. Perry, while J. Hanson and H. E. Huxley describe in detail their fascinating studies on the fine structure of muscle and its possible significance for contraction. B. R. Malcolm provides some observations on the infrared spectrum of muscle. H. H. Weber discusses the link between metabolism and motility of cells and muscles, with stress on the free energy released by the

breakdown of adenosine triphosphate as the inferred source of the driving energy for these processes.

There are two excellent papers on flagella and cilia of bacteria and animals—one by W. T. Astbury, E. Beighton, and C. Weibull and the other by J. R. G. Bradfield. Only one paper, by J. B. Speakman, discusses keratin, and this paper is extremely interesting. In the last two contributions, D. Mazia discusses the organization of the mitotic apparatus and J. G. Gall discusses the amphibian oocyte nucleus.

The whole symposium is on a very high level, and the papers that were presented are indispensable to anyone who is seriously concerned with understanding the nature of the fibrous proteins and their functions in biology. The illustrations are numerous and excellent. The discussion reveals our ignorance of both the structures of collagen and the true molecular basis of cell motility and muscular contraction in spite of all the fascinating information that has been obtained. Recent studies by Rich and Crick [*Nature* 176, 915 (1955)] and by Cowan, McGavin, and North [*Nature* 176, 1062 (1955)] may represent major steps in the elucidation of the former problem. In any case, those who are still searching for the answers to such problems will find the material presented in this book indispensable.

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Dielectric Behavior and Structure. Dielectric constant and loss, dipole moment and molecular structure. Charles Phelps Smyth. McGraw-Hill, New York-London, 1955. x + 441 pp. Illus. \$9.

The last two decades have been marked by rapid growth in both theoretical and experimental knowledge of dielectric behavior. As a result, the field of dielectrics has reached a point where it is no longer convenient to treat thoroughly both aspects in a single concise volume. Several authoritative textbooks have appeared recently in which major emphasis has been devoted to general foundations and theory. *Dielectric Behavior and Structure*, on the other hand, has been written primarily from the viewpoint of the experimentalist who is concerned with utilizing dielectric measurements to obtain specific information regarding the structure of liquids and solids and of individual molecules. In subject matter, it bears little resemblance to the author's earlier monograph. Progress during the intervening years, to which Smyth and his associates at Prince-

ton University have made a foremost contribution, has provided a large reservoir of new information and led to many new or revised interpretations.

The general concepts and various theoretical and empirical relationships pertaining to dielectric constant, loss, and dipole moment are discussed in the first two chapters. Although this treatment is necessarily brief and rather noncritical, the reader will find it well documented with references to the original literature and to other recent textbooks. The next four chapters are devoted to a consideration and interpretation of data on the dielectric constant of and dielectric loss in a variety of liquid and solid systems that represent varied types of behavior. The chapter on solids, for example, contains a discussion of polar and nonpolar crystalline solids, ionic crystals, glasses, polymers, ferroelectrics, and electrets. Following a short chapter on methods of measuring dielectric constant and loss are six chapters on dipole moments and their relationship to molecular structure. The various classes of inorganic, organic, and organometallic compounds are treated in systematic fashion. Two concluding chapters deal with amino acids and proteins and with atomic and electronic polarization.

The book appears to be well organized, adequately indexed, and relatively free from typographical errors. It can be recommended for those who are interested in a lucid account of the application of dielectrics to the problems of structural chemistry. Its reference value to the student and research worker alike is considerably enhanced by the inclusion of many figures and tables and by nearly 1500 literature citations.

A. A. MARYOTT

National Bureau of Standards

Arctic Research. The current status of research and some immediate problems in the North American Arctic and Subarctic. Spec. Publ. No. 2 of The Arctic Institute of North America (reprinted from *Arctic*, vol. 7, Nos. 3 and 4, pages 113-366). Diana Rowley, Ed. Arctic Institute of North America, Montreal, Canada, 1955. 261 pp. Illus. \$3.50; members, \$3.

This is a collection of research papers in the physical, biological, and social sciences about the arctic and subarctic of North America. The principal topics covered in the physical sciences are meteorology, geology and geomorphology, glaciology, permafrost, geophysical research and exploration, the ionosphere, geodetic investigations, oceanography, tidal data, and sea ice; topics in the biological sciences are limnology, marine

ecology, botany, soil resources and agriculture, wildlife research, invertebrate zoology, entomology, and biological research; topics in the social sciences are archeological research, human ecology, human geographic research, settlement and transportation, and cold acclimatization in the Eskimo. All articles have bibliographies; lists of field and library projects sponsored by the Arctic Institute are included. There is an index and a folding map inside the back cover.

New Books

The Technique of Operative Surgery, vol. 1, *The Operations of the Billroth II Type* (in three languages). Raimund Wittmoser. English translation by John C. Foster; French translation by A. Jost. Maudrich, Vienna, 1956. 350 pp. \$12.84.

Mechanical Engineering Practice. A laboratory reference text. Charles F. Shoop and George L. Tuve. McGraw-Hill, New York, ed. 5, 1956. 471 pp. \$7.

Expanding Universes. E. Schrodinger. Cambridge University Press, Cambridge, 1956. 93 pp. \$3.50.

Statistics, A New Approach. W. Allen Wallis and Harry V. Roberts. Free Press, Glencoe, Ill., 1956. 646 pp. \$6.

The Laws of Nature. R. E. Peierls. Scribner's, New York, 1956. 284 pp. \$4.50.

Essentials of Quantitative Analysis. An introduction to the basic unit operations. A. A. Benedetti-Pichler. Ronald, New York, 1956. 666 pp. \$15.

Les Mécanismes cérébraux de la prise de conscience. Neurophysiologie, psychanalyse, et psychologie animale. Paul Chaud. Masson, Paris, 1956. 240 pp. F. 1300.

St. Paul's Journeys in the Greek Orient. Studies in Biblical Archaeology No. 4. Henri Metzger. Philosophical Library, New York, 1955. 75 pp. \$2.75.

Rapid Calculations. A. H. Russell. Emerson Books, New York, 1956. 287 pp. \$2.95.

Introduction to Plasticity. Aris Phillips. Ronald, New York, 1956. 230 pp. \$7.

The Americana Annual, 1956. An encyclopedia of the events of 1955. Lavinia P. Dudley and John J. Smith. Americana Corp., New York, 1956. 866 pp.

XIVth International Congress of Pure and Applied Chemistry. Main congress lectures and lectures in the sections. Birkhäuser, Basel, Switzerland, 1955. 287 pp. F. 32.

Radiation Biology, vol. III, *Visible and Near-Visible Light*. Alexander Hollaender, Ed. McGraw-Hill, New York, 1956. \$10.

General Botany. William T. Taylor and Richard J. Weber. Van Nostrand, Princeton, N.J., 1956. 376 pp. \$5.75.

The Prevention of Cruelty to Children. Leslie George Housden. Philosophical Library, New York, 1956. 406 pp. \$7.50.

World Symposium on Applied Solar Energy, Proceedings. Held at Phoenix, Ariz., 1-5, Nov. 1955. Sponsored by Association for Applied Solar Energy, Stanford Research Institute, and University of Arizona. Association for Applied Solar Energy, Phoenix, Ariz., 1956. 304 pp. \$5.

Noradrenaline. Chemistry, physiology, pharmacology and clinical aspects. U. S. von Euler. Thomas, Springfield, Ill., 1956. 382 pp. \$11.50.

An Outline of Social Psychology. Muzaffer Sherif and Carolyn W. Sherif. Harper, New York, rev. ed., 1956. 792 pp. \$6.

Police Drugs. Jean Rolin; translated by Laurence J. Bendit. Appendix on *Narcosis* by Edward V. Saher. Philosophical Library, New York, 1956. 194 pp. \$4.75.

The New Psychology for Leadership. Based on researches in group dynamics and human relations. Donald A. Laird and Eleanor C. Laird. McGraw-Hill, New York, 1956. 226 pp. \$4.

Psychoanalysis and Psychotherapy. Developments in theory, technique, and training. Franz Alexander. Norton, New York, 1956. 299 pp. \$4.75.

Wonder World of Microbes. Madeleine P. Grant. Whittlesey House, McGraw-Hill, New York, 1956. 160 pp. \$2.75.

Trigonometrical Series. Antoni Zygmund. Chelsea, New York, ed. 2, 1952. 329 pp. Cloth, \$4.95; paper, \$1.50.

Tables of Weber Parabolic Cylinder Functions. Computed by Scientific Computing Service Limited. Mathematical introduction by J. C. P. Miller. Her Majesty's Stationery Office, London, 1955 (order from British Information Service, New York). 233 pp. \$11.68.

Surface Area. Lamberto Cesari. Princeton University Press, Princeton, N.J., 1956. 595 pp. \$8.50.

The World of Plant Life. Clarence J. Hylander. Macmillan, New York, ed. 2, 1956. 653 pp. \$8.95.

Man, His Life, His Education, His Happiness. A. Da. Silva Mello (translated from the Portuguese by M. B. Fierz). Philosophical Library, New York, 1956. 729 pp. \$6.

Modern Chemical Processes. A series of articles describing chemical manufacturing plants. vol. 4. Editors of *Industrial and Engineering Chemistry* and the technical staffs of the cooperating organizations. Reinhold, New York; Chapman & Hall, London, 1956. 202 pp. \$5.

Handbuch der Laplace-Transformation, vol. II, *Anwendungen der Laplace-Transformation*. Gustav Doetsch. Birkhäuser, Basel-Stuttgart, 1955. 436 pp. DM. 52.

Faculty Requirements and Standards in Collegiate Schools of Business. Proceedings of a Conference on Professional Education for Business held 27-29 Oct. 1955 at Arden House, Harriman Campus of Columbia University. American Association of Collegiate Schools of Business, New York, 1955. 216 pp.

Geometrical Optics. L. C. Martin. Philosophical Library, New York, 1956. 215 pp. \$7.50.

Germanium Diodes. S. D. Boon. Philips Technical Library, Eindhoven, Netherlands, 1956. 85 pp.

Genetics. The modern science of heredity. Edward O. Dodson. Saunders, Philadelphia, 1956. 329 pp.

Chemical Applications of Spectroscopy, vol. IX of *Technique of Organic Chemistry*. W. West, Ed. Interscience, New York, 1956. 787 pp. \$15.

Scientific Meetings

Meeting Notes

■ The National Science Fair, which is conducted by Science Clubs of America and administered by Science Service, took place in Oklahoma City, 10-12 May. The annual event, which has expanded to seven times its size in 1950, attracts high school students whose exhibits have already won prizes in local competition. Not more than two finalists from each local fair are given all-expense-paid trips to the national event.

The 217 high-school students who exhibited their prize-winning projects at the seventh annual fair represented 111 regional fairs, 42 of which are new. These students competed for more than \$2500 in awards.

■ More than 350 scientific reports were delivered at the 56th general meeting of the Society of American Bacteriologists in Houston, Tex., 29 Apr.-4 May. Some 44 papers dealt with recent developments in the field of antibiotics and chemical antibacterial and antiviral agents. Other presentations reported on new work in preventative vaccines. One of these was a polyvalent vaccine against the new group of respiratory diseases, the adenopharyngeal-conjunctival virus infections. A new plague vaccine was described, and further improvements on rabies vaccines and on B.C.G. vaccines for tuberculosis were discussed.

In addition to the medical and viral study reports, there were papers on dentistry, forestry, and veterinary medicine, and on the role of bacteria in mineral sulfur deposits, and the effect of asphalt-eating bacteria on the breakdown of highway road beds.

The evening sessions were devoted to a series of nine symposia on industrial fermentations in antibiotic production, on enterobacteriaceae of medical significance in typhoid fever, food poisoning, and dysentery outbreaks; on microbial amino-acid metabolism or bacteria-producing amino acids and other growth factors; on analytical microbiology, including testing of antiseptics and growth factors; on new aspects of water bacteriology, including new techniques for checking the sanitary quality of drinking water supplies; on studies of the enzyme

systems involved in bacterial cells; on the latest advances in teaching bacteriology and training new workers in the field; and on the role of bacteria in the petroleum industry.

On 1 May, a series of twelve motion pictures was shown. These ranged from pictures showing what goes on inside the bacterial cell to studies on vaccination against tuberculosis.

Some 34 companies displayed exhibits of scientific and mechanical interest, and in addition there was a group of exhibits contributed by various educational institutions and research laboratories.

■ The 21st Cold Spring Harbor Symposium on Quantitative Biology will be held in Cold Spring Harbor, N.Y., 4-12 June. The theme of the meeting will be "Genetic mechanisms—structure and function." In the presentations and discussions, genetic mechanisms will be considered on the chemical, genic, chromosomal, cellular, and developmental levels.

The symposium is open to all who are interested, but because of space limitations it is important to make reservations. For information, write to the Biological Laboratory, Cold Spring Harbor, N.Y.

■ A tentative program has been outlined for the 32nd annual meeting and 29th scientific session of the American Heart Association to be held in Cincinnati, Ohio, 26-31 Oct. The scientific sessions will begin on 26 Oct. and continue through 29 Oct. The organizational meetings of the association will follow the scientific presentations.

Deadline for submission of abstracts of technical papers is 15 June. Papers based on original studies in clinical, laboratory and epidemiologic research are eligible for consideration. Abstracts of no more than 300 words must be prepared on special forms that are available from the medical director of the American Heart Association, 44 E. 23 St., New York 10.

■ The National Academy of Sciences-National Research Council's Advisory Board on Quartermaster Research and Development recently conducted an international Symposium on Protection and Functioning of the Hands in Cold

Climates at the Quartermaster Research and Development Center in Natick, Mass. The 2-day meeting was conducted in four sessions.

The panel that discussed physiological factors was moderated by Austin Henschel. The second session, which dealt with psychological and anthropological factors, was directed by Warren H. Teichner, and Robert L. Woodbury was chairman of the third session, a discussion of operational requirements. The closing session was devoted to approaches to the problem and was led by Peter W. Webb.

The meeting was attended by representatives of the Quartermaster Corps, the U.S. Army technical services, educational and research institutions, industry, and the Canadian Army.

Society Elections

■ Federation of American Scientists: chairman, Charles C. Price, University of Pennsylvania; v. chairman, Martin Deutsch, Massachusetts Institute of Technology; sec., Harry Palevsky, Brookhaven National Laboratory; treas., Mortimer M. Elkind, National Cancer Institute.

■ American Society for Artificial Internal Organs: pres., C. Dennis; pres. elect., P. F. Salisbury; sec.-treas., G. H. A. Clowes.

■ International Association for Dental Research: pres., Joseph F. Volker, University of Alabama School of Dentistry; pres. elect., Reidar F. Sognnaes, Harvard School of Dental Medicine, Boston; v. pres., Ned B. Williams, University of Pennsylvania; sec.-treas., Edward H. Hatton, Northwestern University; asst. sec.-treas., Dan Y. Burrill.

■ The National Speleological Society: pres., William E. Davies; treas., Burton S. Faust. The vice presidents are John D. Parker, Brother George G. Nicholas, Albert G. Mueller, George G. Jackson, and James D. McClung.

Forthcoming Events

June

13-14. Conference for Veterinarians, 25th annual, Columbus, Ohio. (J. W. Helwig, College of Veterinary Medicine, Ohio State Univ., Columbus 10.)

13-16. Colloquium of College Physicists, annual, Iowa City, Iowa. (G. W. Stewart, Dept. of Physics, State Univ. of Iowa, Iowa City.)

13-16. Driftless Area Field Trip, La Crosse, Wis. (R. F. Thorne, State Univ. of Iowa, Iowa City.)

16-17. Council of American Bioana-

lysts, Dallas, Tex. (M. F. Dooley, 308 S. Bishop, Dallas, Tex.)

17-20. American Soc. of Agricultural Engineers, 49th annual, Roanoke, Va. (F. B. Lanham, ASAE, St. Joseph, Mich.)

17-22. American Soc. of Medical Technologists, annual, Quebec, Canada. (Miss R. Matthaei, Suite 25, Hermann Professional Bldg., Houston 25, Tex.)

17-22. American Soc. for Testing Materials, annual, Atlantic City, N.J. (R. J. Painter, ASTM, Philadelphia 3, Pa.)

17-23. American Library Assoc., annual, Miami Beach, Fla. (D. H. Clift, 50 E. Huron St., Chicago 11, Ill.)

17-23. International Cong. on Acoustics, 2nd, in conjunction with Acoustical Soc. of America, Cambridge, Mass. (E. H. Kone, American Inst. of Physics, 57 E. 55 St., New York 22)

17-23. World Confederation for Physical Therapy, 2nd international cong., New York, N.Y. (Miss M. Elson, American Physical Therapy Assoc., 1790 Broadway, New York 19.)

17-23. World Power Conf. (invitation), 5th plenary, Vienna, Austria. (S. E. Reimel, Engineers Joint Council, 29 W. 39 St., New York 18.)

17-30. West Coast Science Teachers Summer Conf., Corvallis, Oreg. (R. H. Carleton, National Science Teachers Assoc., 1201 16 St., NW, Washington 6.)

18-20. American Neurological Assoc., 81st annual, Atlantic City, N.J. (C. Rupp, ANA, 133 S. 36 St., Philadelphia 4, Pa.)

18-20. American Soc. of Heating and Air-Conditioning Engineers, Washington, D.C. (A. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)

18-21. Institute of Aeronautical Sciences, Inc., annual summer, Los Angeles, Calif. (S. P. Johnston, 2 E. 64 St., New York 21.)

18-21. Phi Lambda Upsilon, triennium convention, Ann Arbor, Mich. (T. B. Cameron, Dept. of Chemistry, Univ. of Cincinnati, Cincinnati 21, Ohio.)

18-22. American Physical Therapy Assoc., annual, New York. (Miss M. Elson, APTA, 1790 Broadway, New York 19.)

18-22. Medical Library Assoc., 55th annual, Los Angeles, Calif. (A. N. Brandon, Library, College of Medical Evangelists, Loma Linda, Calif.)

18-24. Acoustical Soc. of America, Cambridge, Mass. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

19-22. American Dairy Science Assoc., annual, Storrs, Conn. (H. F. Judkins, 32 Ridgeway Circle, White Plains, N.Y.)

20-21. Symposium on Diffusion and Flow Processes in Polymers, Madison, Wis. (W. J. Lyons, Quartermaster Research and Development Command, Natick, Mass.)

20-22. American Assoc. of Physics Teachers, annual, Toronto, Ont., Canada. (F. Verbrugge, Carleton College, Northfield, Minn.)

20-22. Ciba Foundation Symposium on Endocrinology (invitation), London, England (G. E. W. Wolstenholme, 41 Portland Place, London, W.1.)

20-28. International Union for the Protection of Nature, Edinburgh, Scotland. (J. P. Harroy, IUPN, 42, rue Montoyer, Brussels, Belgium.)

21-23. American Physical Society, New

Haven, Conn. (K. K. Darrow, Columbia Univ., New York 27.)

21-23. American Physical Society, Eugene, Ore. (W. A. Nierenberg, Univ. of California, Berkeley 4.)

21-23. Soc. of Nuclear Medicine, annual, Salt Lake City, Utah. (R. G. Moffat, 2656 Heather St., Vancouver 9, Canada.)

21-24. American Acad. of Dental Medicine, 10th annual, Detroit, Mich. (G. J. Witkin, AADM, 45 S. Broadway, Yonkers 2, N.Y.)

21-24. American Soc. of Ichthyologists and Herpetologists, 36th annual, Higgins Lake, Mich. (R. M. Bailey, Museum of Zoology, Univ. of Michigan, Ann Arbor.)

25-27. Symposium on Uses of High Temperatures in Science and Industry, Berkeley, Calif. (N.K. Hiester, Stanford Research Inst., Menlo Park, Calif.)

25-29. American Soc. for Engineering Education, annual, Ames, Iowa. (W. Leighton Collins, Univ. of Illinois, Urbana.)

25-29. American Inst. of Electrical Engineers, Summer and Pacific General, San Francisco, Calif. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

25-29. Alpha Chi Sigma Fraternity, biennial convention, University Park, Pa. (J. R. Kuebler, 5503 E. Washington St., Indianapolis 19, Ind.)

25-29. International Cong. on Physiology Pathology of Animal Reproduction and of Artificial Insemination, 3d, Cambridge, England. (J. Edwards, Production Div., Milk Marketing Board, Thames Ditton, Surrey, England.)

25-30. International Assoc. for Bridge and Structural Engineering, 5th cong., Lisbon, Portugal. (M. L. Gretner, Swiss Federal Inst. of Technology, Zurich, Switzerland.)

26-28. Entomological Soc. of America, Pacific Branch, Berkeley, Calif. (L. M. Smith, Dept. of Entomology, Univ. of California, Davis.)

26-29. American Home Economics Assoc., annual, Washington, D.C. (Miss M. Horton, AHEA, 1600 20 St., NW, Washington 9.)

28-1. International Scientific Conf. of Rheumatism, Aix-les-Bains, France. (M. Graber-Duvernay, 6, rue de Liege, Aix-les-Bains.)

11-15. Conf. on Industrial Research, 7th annual, Harriman, N.Y. (R. T. Livingston, 409 Engineering, Columbia Univ., New York 27.)

28-1. Symposium on Comparative Biology of Aquatic Species, Roscoff, Brittany, France. (G. Montalenti, Istituto di Genetica, Naples, Italy.)

July

1-7. International Conf. on Nuclear Reactions, Amsterdam, Netherlands. (S. A. Wouthuysen, Zeeman Laboratorium, Pl. Muidergracht 4, Amsterdam (C).)

1-7. National Education Assoc., Portland, Oreg. (W. G. Carr, NEA, 1201 16 St., NW, Washington, D.C.)

2. Astronomical League, Miami, Fla. (W. A. Cherup, 4 Klopfer St., Millvale, Pittsburgh 9, Pa.)

2. Gamma Sigma Delta Biennial Conclave, Ames, Iowa. (J. A. Johnson, Dept. of Flour and Feed Milling Industry, Kansas State College, Manhattan.)

2-3. National Science Teachers Assoc., Corvallis, Oreg. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

2-7. Brazilian Soc. for the Progress of Science, 8th annual, Ouro Preto, Minas Gerais. (Sociedade Brasileira para o Progresso da Ciencia, Caixa Postal 2926, São Paulo, Brazil.)

6-14. International Union of Forestry Research Organizations, 12th cong., Oxford, England. (Secretariat of Union, Viale delle Terme di Caracalla, Rome, Italy.)

9-11. Symposium on Chemical Additives in Foods, 2nd of 5 symposiums, Amsterdam, Netherlands. (H. F. DuPont, International Bureau of Analytical Chemistry, 18 Ave. de Villars, Paris 7, France.)

11-14. American Malacological Union, annual, San Diego, Calif. (Mrs. M. C. Teskey, P.O. Box 238, Marinette, Wis.)

12-14. International Astrophysical Symposium on Molecules in Cosmic Sources, 7th, Liege, Belgium. (H. C. Urey, Inst. for Nuclear Studies, Univ. of Chicago, Chicago 37, Ill.)

16-17. Symposium on Synthetic Polymer Chemistry, Notre Dame, Ind. (G. F. D'Alelio, Dept. of Chemistry, Univ. of Notre Dame, Notre Dame.)

16-21. French Assoc. for the Advancement of Science, Dijon, France. (Mlle. Henri-Martin, Secretary, 28, rue Serpente, Paris 6°.)

17-26. International Soc. of Photogrammetry, 8th cong., Stockholm, Sweden. (P. O. Fagerholm, Bragevägen 8, Stockholm, Sweden.)

18-20. Soc. for the Study of Development and Growth, annual, Providence, R.I. (M. V. Edds, Jr., Brown Univ., Providence 12.)

22-27. International Cong. of Pediatrics, 8th, Copenhagen, Denmark. (Prof. Franconi, Kinderspital, Steinwiesstrasse 75, Zürich 32, Switzerland.)

22-28. International Cong. on Housing and Town Planning, Vienna, Austria. (H. van der Weijde, International Federation for Housing and Town Planning, Paleisstraat 5, The Hague, Netherlands.)

22-28. International Cong. of Radiology, 8th, Mexico, D.F., Mexico. (J. Noriega, Tepic 126, 2° piso, Mexico, D.F. 7.)

23-26. International Cong. of Developmental Biology, 1st, Providence, R.I. (J. W. Wilson, Dept. of Biology, Brown Univ., Providence.)

25-27. Conf. on Solar-Weather Relationships sponsored by American Meteorological Soc., Boulder, Colo. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

26-28. International Conf. on Biochemical Problems of Lipids, 3rd, Brussels, Belgium. (R. Ruysen, St. Jansvest 12, Univ. of Ghent, Ghent, Belgium.)

27-31. Symposium on Cytodifferentiation (invitation), Providence, R.I. (J. W. Wilson, Dept. of Biology, Brown Univ., Providence.)

27-7. International Limnology Cong., 13th, Helsinki, Finland. (H. Luther, Snellmangatan 16 C 36, Helsinki.)

30-4. International Physiological Cong., 20th, Brussels, Belgium. (J. J. Reuse, Faculté de Médecine, 115 Boulevard de Waterloo, Brussels.)

Kodak reports to laboratories on:

filters to match your color film to your photomicrographic light source... bloody business at Fall River... copy negatives on a film with a peculiar H & D curve

What the brain discounts

Color perception is something personal and indescribable that goes on inside your head. A ripe tomato, a lump of carnotite, or the eyes of a flaxen-haired girl look just as meetly and respectively red, yellow, or blue whether seen by candlelight or under a cold north sky. Between the flame and the sky there is a vast difference in the constitution of the light that these things reflect into the eye of the beholder, yet his brain discounts the physical difference and sets all to rights.

Now just because you happen to find yourself past the middle of the sixth decade of the twentieth century, you expect to feel these and all other possible color-feelings through the agency of varying amounts of three factory-standardized dyes on a piece of film. And, marvel to tell, you can come pretty close.

It's just that in the manufacture of a reversal-type color film, a commitment must be made as to light source. If the light source used differs from the one assumed, the physical parameters (they're the only kind available) must be manipulated to meet the psychophysical necessities. The manipulation can be done with dyed gelatin filters placed somewhere along the line. Here, for example, are our recommendations for some light sources common in photomicrography:

Light source	*Correction filters for		
	Kodak Ektachrome Film, Type B (sheet only)	Kodak Ektachrome Film, Type F	Kodachrome Professional Film, Type A
4-v ribbon or coil filament	82A	82A and 82C	82C
300 to 750-w coil filament	match†	82 and 82C	82A
titanium arc	28	82, 82C, and 28	82A and 28
carbon arc (4.5 amp)	81D and 28	82 and 28	81C and 28

As for the choice to make in 35mm, look at it this way: If you seek comfort in knowing that your color film is capable of the highest resolving power and acutance that the market currently affords, pick the new *Kodachrome Professional Film, Type A*. Pick *Kodak Ektachrome Film, Type F*, if you want the results at once.

Still another choice might have to be made when the only all-night drug store in the neighborhood has no other 35mm color material than *Kodachrome Film, Type F*. This gives just as good definition as the *Kodachrome Professional*, but, like *Type F Ektachrome*, is balanced for the amateur's flash bulbs and therefore requires the same correction with photomicrographic light sources. The filtering cuts the speed down somewhat lower than that of the other two 35mm choices.

"82," "82A," "82C," "81C," and "81D" are all Kodak Light Balancing Filters; "28" is a Kodak Wratten Filter, which absorbs ultraviolet. The Kodak dealer can fix you up. If you want the filters in 35-mm very thin glass mounts for insertion in the filter receptacle below the substage diaphragm, he'll probably have to write in to us. He won't mind at all, particularly if you have accustomed him to minister to your needs.

Truly blood

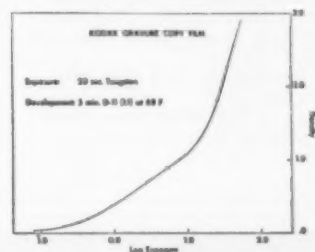
John D. MacPhail likes *p,p'-Benzylidenebis(N,N-dimethylaniline)* (Eastman 3620) better than the classic benzidine for the identification of bloodstains because he finds it more specific. Doing business as Forensic Science Service (144 Third Street, Fall River, Mass.), Mr. MacPhail knows how to keep legal evidence intact. He moistens a filter paper with 0.1N saline and merely presses it against an edge of an old stain suspected as blood. Then he touches the paper (not the stain) with one glass rod dipped in a 1:240 solution of Eastman 3620 in 40% acetic acid. A second time he touches it with another glass rod dipped in an 11:30 solution of sodium perborate in 40% acetic acid. If the paper turns blue-green after the second touch, Mr. MacPhail knows the spot is truly blood. Perhaps something in the bloodstain releases from the sodium perborate the oxygen to oxidize our compound to its far better known form, malachite green, a common dyestuff named for its color resemblance to the brilliant copper mineral malachite.

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grain; presto, twenty years of human violence had gone by and it was time to reorder. (The price is \$2.20 for 5 g.) The second lot we supplied worried Mr. MacPhail. It was green enough in the stock solution to invite sarcastic questions from lawyers. We suggested that he add a little sodium bisulfite to redress the redox balance leucowards. Now Mr. MacPhail reports he is all set again.

Yes, and if you want the balance the other way we can supply Malachite Green Oxalate (Eastman 1264). Among 3500-odd organics, the chance of finding what you want is encouraging. All from Distillation Products Industries, Rochester 3, N. Y. (Division of Eastman Kodak Company).

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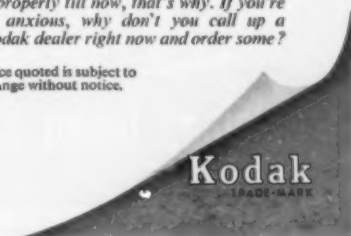


Just as some fortunate people are able to turn the pages of a Brahms score and hear the lovely music in the mind, so also a few (perhaps not quite so fortunate) can look at this curve and say, "Yup, a good long straight-line portion and then, as you go to your higher densities, your contrast starts going higher and higher. That's funny. An H & D curve is supposed to have a shoulder. Where contrast falls off when you get past the straight-line part. This shoulder is inside out. *Kodak Gravure Copy Film*, eh? Ought to be good for making copy negatives from pictures where the highlights are washed out. You could get some of the old lost zip back. Why did they have to wait till now to come out with it?"

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August

1-6. International Cong. of Human Genetics, 1st, Copenhagen, Denmark. (Secretariate, 1st ICHG, 14, Tagensvej, Copenhagen, N.)

5-10. International Conf. of Social Work, 8th, Munich, Germany. (J. R. Hoffer, 345 E. 46 St., New York 17.)

6-10. Poultry Science Assoc., annual, Raleigh, N.C. (C. B. Ryan, Dept. of Poultry Husbandry, Texas A & M College, College Station.)

6-1. International Mathematical Symposium on Algebraic Topology and Its Applications, Mexico City, Mexico. (Miss J. Silva, Instituto de Matemáticas, Torre de Ciencias, Ciudad Universitaria, México 20, D.F.)

9-18. International Geographical Cong., 18th, Rio de Janeiro, Brazil. (H. O'R. Sternberg, Centro de Pesquisas de Geografia do Brasil, Faculdade Nacional de Filosofia, Av. Presidente Antonio Carlos 40, Rio de Janeiro.)

15-22. Canadian Teachers' Federation, Fredericton, N.B., Canada. (G. G. Crosskey, 444 MacLaren St., Ottawa, Ont.)

16-21. Symposium on X-Ray Microscopy and Microradiography, Cambridge, England. (W. C. Nixon, Cavendish Lab., Cambridge.)

17-25. International Cong. of Entomology, 10th, Montreal, Canada. (J. A. Downes, Div. of Entomology, Science Service Bldg., Ottawa, Ont., Canada.)

19-23. International Cong. on Diseases of the Chest, 4th, Cologne, Germany. (Executive Offices, American College of Chest Physicians, 112 E. Chestnut St., Chicago 11, Ill.)

19-24. International Symposium on Combustion, 6th, New Haven, Conn. (Combustion Symposium Office, Mason Lab., Yale Univ., 400 Temple St., New Haven 11.)

20-21. Mathematical Assoc. of America, 37th summer, Seattle, Wash. (H. M. Gehman, Univ. of Buffalo, Buffalo 14, N.Y.)

20-21. National Telemetering Conf., Los Angeles, Calif. (R. E. Rawlins, Lockheed Aircraft Corp., Burbank, Calif.)

20-24. Conf. on Scientific and Technical Writing, Philadelphia, Pa. (H. F. Arader, Univ. of Pennsylvania, 3400 Walnut St., Philadelphia 4.)

20-24. Institute of Mathematical Statistics, Seattle, Wash. (G. E. Nicholson, Jr., Dept. of Statistics, Univ. of North Carolina, Chapel Hill.)

20-24. International Cong. of Physical Medicine, 2nd, Copenhagen, Denmark. (S. Clemmesen, Kommunehospitalet, Copenhagen.)

20-25. American Mathematical Soc., 61st summer, Seattle, Wash. (J. H. Curtiss, AMS, 80 Waterman St., Providence 6, R.I.)

22-29. World Cong. of Sociology, 3rd, Amsterdam, Netherlands. (T. B. Bottomore, Skepper House, 13 Endsleigh St., London, W.C.1, England.)

26-30. American Inst. of Biological Sciences, Storrs, Conn. (H. T. Cox, 2000 P St., NW, Washington 6.)

The following 23 meetings are being held in conjunction with the AIBS meeting at Storrs, Conn.

26-30. American Bryological Soc. (L. J. Gier, Dept. of Biology, William Jewell College, Liberty, Mo.)

26-30. American Fern Soc., annual. (Mildred E. Faust, 501 University Pl., Syracuse 10, N.Y.)

26-30. American Microscopical Soc. (R. W. Pennak, Dept. of Biology, Univ. of Colorado, Boulder.)

26-30. American Soc. for Horticultural Science, annual. (F. S. Howlett, Ohio Agricultural Experimental Station, Wooster, Ohio.)

26-30. American Soc. of Human Genetics. (E. J. Gardner, Dept. of Zoology, Utah State Agricultural College, Logan.)

26-30. American Soc. of Limnology and Oceanography, annual. (B. H. Ketchum, Woods Hole Oceanographic Institution, Woods Hole, Mass.)

26-30. American Soc. of Parasitologists, annual. (A. C. Walton, Knox College, Galesburg, Ill.)

26-30. American Soc. of Plant Physiologists, annual. (A. W. Galston, Dept. of Botany, Yale Univ., New Haven, Conn.)

26-30. American Soc. of Plant Taxonomists, annual. (R. C. Rollins, Gray Herbarium, Harvard Univ., 22 Divinity Ave., Cambridge 38, Mass.)

26-30. Biometric Soc., ENAR. (A. M. Dutton, Univ. of Rochester, Box 287, Station 3, Rochester 20, N.Y.)

26-30. Botanical Soc. of America, annual. (H. C. Bold, Vanderbilt Univ., Nashville, Tenn.)

26-30. Ecological Soc. of America, annual. (J. F. Reed, Dept. of Botany, Univ. of Wyoming, Laramie.)

26-30. Mycological Soc. of America, annual. (C. J. Alexopoulos, Dept. of Botany, Michigan State Univ., East Lansing.)

26-30. National Assoc. of Biology Teachers. (P. V. Webster, Bryan City Schools, Bryan, Ohio.)

26-30. Nature Conservancy. (G. B. Fell, 4200 22 St., NE, Washington 18.)

26-30. Phycological Soc. of America, annual. (P. C. Silva, Dept. of Botany, Univ. of Illinois, Urbana.)

26-30. Soc. of General Physiologists. (A. M. Shanes, National Inst. of Arthritis and Metabolic Diseases, Bethesda 14, Md.)

26-30. Soc. for Industrial Microbiology, annual. (C. P. Porter, Dept. of Biological Sciences, Purdue Univ., West Lafayette, Ind.)

26-30. Soc. of Protozoologists, annual. (N. D. Levine, College of Veterinary Medicine, Univ. of Illinois, Urbana.)

26-30. Soc. of Systematic Zoology. (R. E. Blackwelder, 3728 Second St. South, Arlington 4, Va.)

27-29. American Soc. of Zoologists, 53rd annual. (R. T. Kempton, Marine-land Research Lab., Marineland, Fla.)

27-29. Genetics Soc. of America, annual. (H. B. Newcombe, Atomic Energy of Canada, Ltd., Chalk River, Ont.)

27-31. American Soc. of Naturalists, annual. (B. Wallace, Biological Lab., Cold Spring Harbor, Long Island, N.Y.)

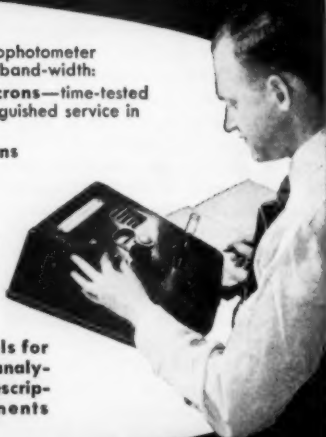
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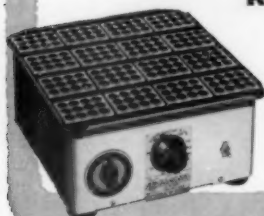
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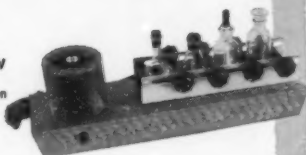
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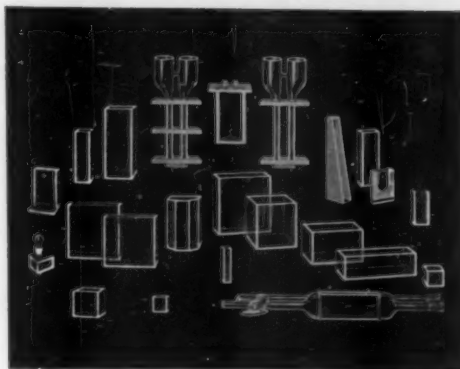
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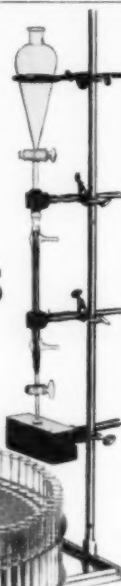
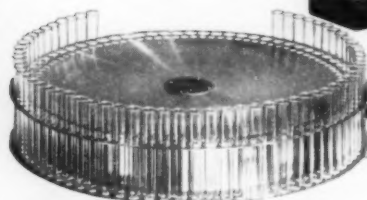
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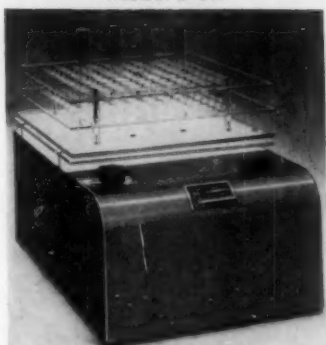
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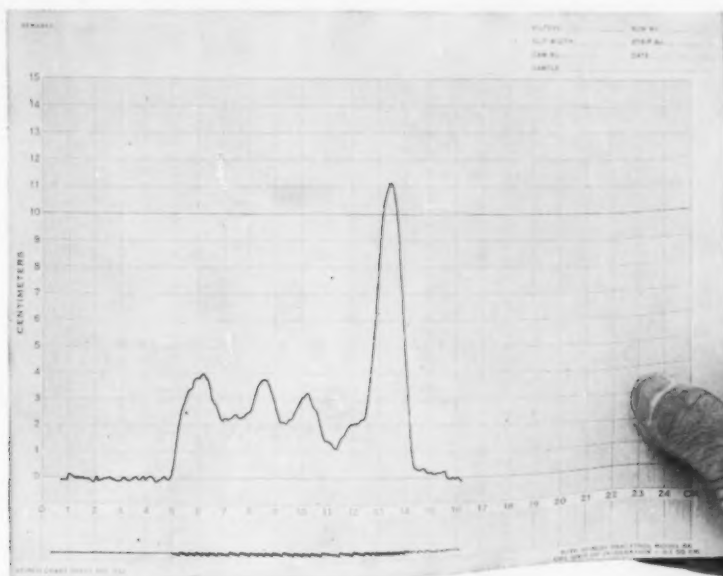
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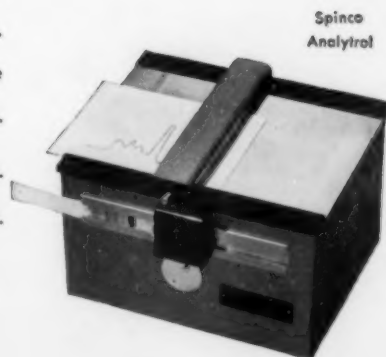


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